O'LEVEL BIOLOGY ITEM BANK

A ROUTE TO EXCELLENCE

The competency based curriculum

BY

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Foreword

This item bank is aligned to the Uganda National Lower Secondary Curriculum (NLSC) and End-of-Cycle Assessment Framework.

It is a comprehensive Biology Item Bank that has been thoughtfully designed for both learners and teachers working within Uganda's Competency-Based Curriculum (CBC). It mirrors the official structure and expectations of the end-of-cycle national assessment, providing both theory and practical-based tasks that reflect real assessment conditions.

Purpose and Educational Value of this book

This item bank is an essential tool for:

Learners, offering realistic CBC-style questions and practical tasks to guide preparation and revision.

Teachers, providing high-quality, ready-to-use assessment items and a solid framework for CBC-aligned test setting.

In a nutshell, this resource is not merely a compilation of questions; it is a competency-driven academic tool designed to enhance instruction, reinforce practical scientific literacy, and prepare learners for assessment success in both theory and practice. With its faithful alignment to the biology elements of construct, it bridges the gap between curriculum objectives and learner performance.

Open the pages and step into a Biology experience that is rigorous, skill-based, and fully CBC-compliant.

The following are selected items with suggested responses according to the biology elements of construct and the End of Cycle paper structure.

ITEM 1 (ELEMENT OF CONSTRUCT 2)

Plant biology (Botany).

The learner Understands how plants obtain and use nutrients to meet their requirements during which raw materials and products are carried to and from various organs involved.

Topics and subtopics examined here include;

- *Nutrition in plants*
- *Transport in plants*
- *Respiration in plants*
- *Growth & development in plants*

Success criteria.

The learner applies knowledge of plant biology to explain how plants use processes in different organs and structures to overcome challenges experienced.

- ***It is examined on number one in the end of cycle (final) assessment.***

1. At the start of the season, the ministry of agriculture under the parish development model supplied a new variety of tomato seeds to people of Yumbe district. The variety was well known for its high productivity and resistance to disease. Mr. Kidega, one of the renowned farmers in the area and one of the beneficiaries of the program, prepared his garden, applied fertilizers and planted his seeds. After a month, Kidega observed that most of his tomato plants either had their leaves drooped or shed off during hot days. Some of the tomato plants had yellow leaves. He eventually realized a very poor yield at the end of the season.

Task

(a) Identify the challenges faced by plants in the garden.

- ***Water stress/Excessive water loss.***
- ***Mineral nutrient deficiency such as nitrogen and magnesium.***

(b) Which processes in the tomato plants were affected? Explain how the processes affected led to poor tomato yields.

- ***Photosynthesis decreased, because water shortage limited water as a raw material, and stomata closed to reduce excessive water loss by transpiration, which in turn reduced carbon dioxide intake. Shedding of leaves also reduced the surface area for light absorption, further lowering glucose production needed for growth and fruit formation.***
- ***Chlorophyll synthesis was impaired due to nitrogen and magnesium deficiency, causing yellowing of leaves. Although fertilizers were applied, water stress reduced nutrient uptake since mineral ions are absorbed in dissolved form, and the reduced transpiration pull caused by stomatal closure, limited their transport to leaves. This lowered chlorophyll levels, reduced light absorption, and further decreased photosynthesis and food storage.***

- ***<u>Transpiration</u> was reduced because of water stress and stomatal closure as a protective response, lowering the transpiration pull needed to move water and minerals from roots to aerial parts, further limiting growth and fruit development.***
- ***<u>Gaseous exchange</u> was reduced because drooping and shedding of leaves decreased the total leaf surface area, reducing the number of stomata available for carbon dioxide uptake and oxygen release. This limited respiration, reduced ATP production, and slowed cell division and active transport, leading to poor growth and lower yields.***

(c) How can Mr. Kidega improve his tomato yields next season?

- ***Irrigate regularly to ensure adequate water supply.***
- ***Mulch to reduce water loss from the soil.***
- ***Add organic matter to improve soil water retention.***
- ***Apply balanced fertilizers to correct nutrient deficiencies.***
- ***Use proper spacing to reduce competition for water and nutrients.***

2. Herbalists in Gondo village obtain plant structures for use in processing herbal medicines by removing barks of trees together with most of the leaves and roots. This has greatly affected the number of some plant species in the area. The community members have however noticed some trees developing new roots, buds and barks.

<u>Task</u>

(a) Identify the processes affected by the activities of the herbalists

- ***Translocation***
- ***Photosynthesis***
- ***Water absorption***
- ***Gaseous exchange***

(b) Explain how the actions of the herbalists affected the normal functioning of the plants.

- ***Removal of barks inhibited the movement of manufactured food materials from the leaves to other parts of the plant (translocation) since the phloem is located in the barks.***
- ***Removing leaves reduces the surface area for light absorption and intake of carbon dioxide, hence reduced photosynthetic activity of the plants.***
- ***Removal of roots, destroys the root hairs responsible for absorption of water and dissolved mineral salts from the soil.***
- ***Plucking off leaves reduced number of stomata which reduces entry and exit of gases like oxygen during gaseous exchange, less energy is produced during respiration hence poor plant growth.***

(c) How did some plants manage to survive despite the actions of the herbalists?

- ***There was rapid mitosis resulting into regeneration of new barks with new phloem sieve tubes for transportation of manufactured food from leaves to other parts of the plant such as roots.***
- ***Some plants developed new roots enabling continued absorption of water and dissolved mineral salts from the soil.***
- ***The trees developed new buds leading to formation of new branches with leaves for continued photosynthesis.***

3. Salongo Leonard is a large scale coffee farmer in Dangoma village. This year he is likely to make huge losses, as his plantations are affected with prolonged dry spell. In addition to that, a new nearby chemical factory released chemicals into his garden. The plants showed stunted growth, poor root development, leaves turned yellow and drying and Flowers fell off prematurely.

To avoid total loss, Salongo Leonard invited a crop scientist to his plantations; in his advice, the scientist emphasized continuous application of water mostly at the base of the plant and application of fertilizers for at least once a month to improve on leaf condition and for higher crop yields.

Task

(a) Mention the plant processes that were affected by the climatic condition.

- ***Photosynthesis***
- ***Transpiration***
- ***Absorption of water and mineral salts***
- ***Gaseous exchange***
- ***Fertilization***

(b) Explain the plant processes that were affected by the prevailing conditions in the garden.

- ***Photosynthesis; Reduced because water deficit limited its availability as a reactant, and stomatal closure restricted carbon dioxide intake, while chlorophyll synthesis was impaired due to nutrient deficiencies such as nitrogen and magnesium, and toxic chemical effects, lowering the plant's ability to capture light energy.***
- ***Absorption of water and mineral salts; Decreased as dry soil reduced water availability, and chemical damage to root epidermal cells and root hairs impaired active and passive uptake of water and essential minerals.***
- ***Transpiration; Lowered because stomata closed to minimize water loss, decreasing the transpiration stream that normally drives the upward movement of water and minerals through the xylem.***
- ***Gaseous exchange; Limited as stomatal closure reduced diffusion of carbon dioxide into the leaf for photosynthesis and the release of oxygen as a by-product, affecting overall metabolic activity.***
- ***Fertilization; Disrupted due to premature falling of flowers, preventing successful pollination and the subsequent fusion of male and female gametes necessary for fruit and seed formation.***

(c) Identify the minerals in the fertilizer applied and the role played in the proper functioning of the plants.

- ***Nitrogen: Essential for synthesis of amino acids, proteins, and chlorophyll, promoting healthy leaf growth and improving photosynthesis.***
- ***Phosphorus: Important for root development, energy transfer through ATP, and early plant growth.***
- ***Potassium: Regulates stomatal opening and closing, enhances water use efficiency, and improves disease resistance and flower/fruit development.***
- ***Magnesium: Central element in the chlorophyll molecule, necessary for capturing light energy during photosynthesis.***

(d) Besides the scientist's advice, which other ways would Salongo Leonard use to improve crop yields?

- ***Mulching: Conserves soil moisture by reducing evaporation and maintains optimal soil temperature, promoting root function and nutrient absorption.***
- ***Application of organic manure: Improves soil fertility and structure, enhancing water retention and providing essential nutrients for plant growth.***
- ***Intercropping with leguminous plants: Enhances soil nitrogen levels through nitrogen fixation by Rhizobium bacteria in root nodules, improving soil fertility and boosting coffee growth and yields.***
- ***Planting drought-resistant coffee varieties: Allows plants to maintain physiological activities such as photosynthesis and water uptake during dry periods, reducing stress and yield loss.***
- ***Pest and disease management: Protects plants from damage that reduces photosynthesis and nutrient uptake, helping maintain healthy growth and productivity.***
- ***Proper pruning: Encourages new growth and improves air circulation within the canopy, reducing disease incidence and enhancing light penetration for better photosynthesis.***

4. Kawuma bought a plot of land where he planted beans. Upon the onset of flowering, the garden experienced windy air conditions and heavy sun, which caused most flowers to fold and leaves to fall off, especially during the heat of the day, and would recover during the early morning hours. However, plant growth and productivity were substantially lower than Kawuma's expectations.

Task

(a) Identity the plant processes affected in the garden.

- ***Pollination/Fertilization/Reproduction***
- ***Transpiration***
- ***Photosynthesis***

(b) Explain how the conditions observed in the garden affected plant growth and productivity.

- ***The flowers folded during most hours of the day, preventing the transfer of pollen grains from anthers to the stigma, limiting fertilization and hence limited seed and fruit formation.***
- ***Leaves fell off reducing the surface area for light absorption hence reduced food production by photosynthesis.***
- ***The strong winds led to an increase in the rate of transpiration. This results into water stress that reduces the rate of photosynthesis.***

(c) How did the bean plants manage through the conditions and give some yields?

- ***The flowers remained open during morning hours allowing pollination and fertilization to occur, leading to seed and fruit formation.***
- ***Some leaves fell off reducing the rate of water loss by transpiration.***
- ***Development of many roots to increase the rate of water and mineral absorption from the soil.***
- ***The remaining leaves absorbed sunlight and carried out photosynthesis, producing food for plant use and storage.***

5. Two farmers A and B planted equal acreage of maize in the same season. The garden of farmer A was near an extremely dusty and busy murram road, while the garden of farmer B was very far from the road. The maize plants in the two gardens showed different growth rates, despite being under similar

weather conditions and soil profile. The garden of farmer B was invaded by caterpillars at flowering stage, however the maize managed to give yields before that of farmer A.

Task

(a) Point out the major processes and plant organs affected by the prevailing conditions in the two gardens.

The processes affected include:

- ***Gaseous exchange***
- ***Photosynthesis***
- ***Transpiration***

The organs affected include;

- ***Leaves***
- ***Flowers***
- ***Buds***

(b) Explain how the conditions in the garden of farmer A were responsible for the delayed yields.

- ***A thick layer of dust settled on the leaves of Farmer A's maize plants, blocking stomata and reducing light penetration to the chloroplasts. As a result, the rate of photosynthesis decreased, leading to lower glucose production and reduced synthesis of other organic compounds needed for growth. This limited energy supply and building materials, causing stunted growth, delayed flowering, and slow grain development, thus resulting in delayed yields.***

(c) How did the maize in the garden of farmer B manage to give yields despite all the challenges?

- ***Continuous mitotic cell division in meristematic tissues allowed regeneration of damaged leaves, buds, and flowers, enabling continued photosynthesis and growth.***
- ***Production of additional leaves and flowers replaced those destroyed by caterpillars, maintaining reproductive success.***
- ***Development of more prop roots increased absorption of water and mineral ions, supporting sustained growth and fruit development before severe damage occurred.***

6. An Irish potato farmer in a swampy area had his garden flooded for a long time during prolonged rains experienced in the area. He made the following observations about his garden during the season.

- The leaves of the potato plants turned yellow.
- The potato plants became stunted with weak stems.
- Some potato plants wilted others had rotten roots.

When the rains reduced and the flooding was no more, the Irish potato plants revived, having greener leaves, upright stems and numerous roots. The plants managed to produce Irish potatoes for the farmer.

Task

(a) Explain the observations made by the farmer during the rainy season.

- ***During the flooding, there was leaching of mineral salts like magnesium and nitrates making them unavailable for absorption. This caused chlorosis since these minerals are essential in synthesis of chlorophyll, and reduced photosynthesis.***
- ***The lack of plant nutrients like nitrates and calcium caused failure of proper cell wall formation resulting in plants with weak stems.***
- ***Excess water in soil displaced soil oxygen causing limited aerobic respiration and less energy. The plants could not actively absorb sufficient mineral salts further causing chlorosis and reducing plant growth.***
- ***Lack of soil oxygen led to death and rotting of plant roots since they lacked energy to carry out vital life processes.***

(b) How did the potato plants finally manage to produce Irish potatoes for the farmer?

- ***This occurred due to mitosis that increased the size and number of leaves, therefore the surface area for absorption of sunlight increased hence increasing the photosynthetic activity that increased food production that was used for growth and production of Irish potatoes.***
- ***Because production of more roots increased surface area for absorption of more water, cells became turgid straightening the stem.***
- ***Leaves became more exposed to sunlight so much sunlight was absorbed that increased photosynthesis to produce more food for growth and formation of Irish potatoes.***

7. Mr. Kagoro prepared his garden well and planted beans which were looking healthy for the first three weeks. Suddenly, a dry spell set in and most beans had their leaves turning yellow, and some wilted. At flowering stage though, the garden was invaded by numerous bees for some time. After the visit by the bees, the bean pods started forming and finally the beans gave some yields.

Task

(a) Identify the major challenges faced by the bean plants in Mr. Kagoro's garden.

- ***Water shortage***
- ***Deficiency of nitrogen or magnesium***
- ***Reduced photosynthesis.***

(b) Explain the internal processes that took place in the bean plants from the time bees visited until when the yields were realized.

- ***Bees carried pollen grains from the anthers to the stigma of bean flowers during pollination.***
- ***When the pollen grains landed on a mature stigma, each grain germinated and produced a pollen tube that grew downward through the style, guided by the tube nucleus.***
- ***Inside the pollen tube, the generative nucleus divided by mitosis to form two male nuclei. The pollen tube then entered the ovule through the micropyle and penetrated the embryo sac. After penetration, the tube nucleus degenerated.***
- ***Inside the embryo sac, one male nucleus fused with the egg cell to form a zygote, which developed into the embryo (plumule and radicle). The second male nucleus fused with the polar nuclei to form the primary endosperm nucleus, which developed into the endosperm to nourish the embryo.***
- ***Meanwhile, the ovary wall became the fruit wall (pericarp), and the integuments formed the seed coat (testa).***

(c) How did the beans overcome the prevailing conditions to give some yields?

- ***Production of more roots to increase surface area for water absorption.***
- ***Elongation of tap roots to reach water in deeper layers of the soil.***
- ***Production of more root hairs to increase surface area for water absorption.***
- ***Having/Development of root nodules where the nitrogen-fixing bacteria oxidises nitrogen to form nitrogen compounds used by the plants to recover from nitrogen deficiency.***

8. At the onset of dry season characterized with much sunshine and high temperatures, Anita obtained a bud from a lemon plant and transferred it into a T-cutting she had made on the bark of an orange plant she had picked from a nursery bed. She loosely tied the bud and then placed the potted orange plant near a dusty road and left it to stay outside overnight. In the next morning, she found out that her neighbour's cow had eaten the shoot tip of the orange plant. After one month, she noticed that the orange plant showed a very slight increase in height and the bud from lemon had not turned into a branch although she was watering the orange plant after every two days.
Task:

(a) Point out the processes in orange plant which were affected by the conditions experienced.

- ***Photosynthesis***
- ***Transpiration***
- ***Translocation***
- ***Water and mineral uptake***
- ***Bud (lemon) development***

(b) Describe how Anita's mistakes led to various processes being affected in orange plant.

- ***Placing the orange plant near a dusty road:***

Dust covered the leaves, blocking stomata, which reduced carbon dioxide uptake and transpiration. This led to a low photosynthesis rate, so less food (glucose) was made, and reduced translocation of sugars to support growth. Low transpiration also weakened the upward movement of water and minerals from the roots.

- ***Leaving the plant exposed to high temperatures and sunshine:***

High heat increased water loss through evaporation, but because stomata were blocked by dust, transpiration pull was very low, limiting water and mineral absorption from the soil. This caused wilting, poor nutrient supply, and stunted growth.

- ***Allowing the cow to eat the shoot tip:***

Removal of the shoot tip destroyed the main source of auxins, which are hormones that maintain apical dominance and stimulate growth. Without auxins, growth of the main shoot and the lemon bud was suppressed, and lateral bud development was also poorly controlled.

(c) What would Anita have done so as to enhance normal functioning of the affected processes in the orange plant?

- ***She should have protected the plant from animals e.g. fencing, to keep the shoot tip intact for continuous auxin production.***

- ***She should have kept the plant away from dusty areas so leaves remained clean, allowing proper stomatal function for photosynthesis and transpiration.***
- ***She should have tied the bud firmly but gently to ensure good contact with the cambium for successful union and nutrient flow.***
- ***She should have placed the plant in a moderately sunny and sheltered area to avoid excessive water loss while still supporting healthy growth.***

9. Mr. Kakooza is a prominent farmer in Wakiso district. Recently he hired a new land for crop farming. Later he planted the seeds, few seedlings managed to grow and these later produced crops which were small, with few small flowers and small yellow leaves which later gave low fruit yields. Later when he brought a specialist to analyse the cause of the low yields, the specialist reported that the soils were deficient in some essential mineral ions.

Task:

(a) Identify the plant processes that were affected.

- ***Photosynthesis***
- ***Protein synthesis***
- ***Cell division and growth***
- ***Flower and fruit development***

(b) Explain how the affected plant processes lead to low yields.

- ***Reduced chlorophyll formation: Due to lack of minerals like nitrogen and magnesium, plants could not form enough chlorophyll, leading to yellow leaves and low photosynthesis.***
- ***Low photosynthesis rate: With less chlorophyll, plants produced fewer carbohydrates, reducing energy and materials needed for growth and fruit formation.***
- ***Poor protein synthesis: Deficiency of nitrogen limited formation of amino acids and proteins, affecting overall growth and development.***
- ***Limited cell division and growth: Lack of minerals such as phosphorus affected cell division, resulting in stunted growth and small leaves.***
- ***Poor flower and fruit development: Potassium deficiency reduced flower formation and fruit setting, leading to small and few fruits.***

(c) Why was Mr. Kakooza able to get some yields?

- ***The soil still had small amounts of mineral ions, which supported minimal plant growth.***
- ***Plants reduced their growth rate to survive on the limited nutrients.***
- ***Plants developed deeper or more extensive root systems to absorb the few available minerals.***
- ***Plants redirected the limited nutrients to essential parts like flowers and fruits.***
- ***These adaptations allowed partial development of flowers and fruits, resulting in some (though low) yields.***

10. Badru is a pumpkin farmer in Kitumba village. The village experienced a long dry season characterized by high temperatures, much sunshine and dry windy conditions. During the season, the hairy pumpkin leaves would droop (bend downwards) and flower petals remained closed for a longer part of the day, but they would straighten and open during early morning hours respectively. Badru had a very poor yield of pumpkins.

Task

(a) Mention the processes in the pumpkin plants that were affected by the conditions experienced.

- ***Photosynthesis***
- ***Gaseous exchange/Respiration***
- ***Pollination/Fertilization/Reproduction/Fruit formation***
- ***Transpiration***

(b) Describe how the conditions experienced affected the functioning of the pumpkin plants and led to poor yields.

- ***High temperatures and much sunshine and dry windy conditions increased the rate of transpiration making leaves to droop, hence reducing the surface area for trapping sunlight. This resulted in low rate of food formation by photosynthesis.***
- ***Due to high temperatures and windy conditions, the leaves closed the stomata in attempt to conserve water. This limited intake of carbon dioxide needed for photosynthesis hence reducing yields. Thus less food was synthesized and stored in pumpkin fruits, making them few and small.***
- ***Flowers remained closed for long periods of the day due to high temperatures, much sunshine and wind, hence limiting fertilization and fruit formation.***

(c) Explain how the pumpkins managed to survive the conditions experienced.

- ***By closing stomata and drooping leaves, the plants reduced surface area exposed to the sun and minimized water loss.***
- ***Hairy leaves reduce air movement across the leaf surface, and also trap a layer of moisture; lowering the rate of transpiration.***
- ***Flowers remained closed during hot parts of the day, protecting reproductive structures from heat damage and further water loss.***
- ***Early morning reopening allowed some limited photosynthesis and pollination when temperatures were lower and humidity higher.***

11. Mr Kadimba a farmer in Mityana district intercropped beans within a mature Banana plantation. When the beans were flowering and bananas bearing fruits, the area experienced a heavy hail storm that left the entire garden destroyed. Many bean flowers, leaves and stems were broken to the ground and some banana plants were even uprooted. Mr kadimba did not harvest any beans. Two months later, he observed that the remaining banana plants developed an extensive root system, produced numerous suckers with broad green leaves and straight stems. The banana plantation was restored.

<u>Task</u>

Explain how:
(a) the hail storm affected the beans leading to no harvest that season.

- ***Flower structures like anthers, stigma and others were damaged which prevented successful pollination, fertilisation and fruit formation.***
- ***Leaves were broken, which reduced surface area for light absorption by chlorophyll hence limited photosynthesis and growth resulted in no yields.***
- ***Broken leaves provided a small surface area for diffusion of carbon dioxide through the few remaining stomata hence limited photosynthesis and no yields.***

- ***Breaking of stems destroyed vascular bundles which prevented translocation of food, water and mineral salts thereby preventing photosynthesis and growth.***

(b) the banana plantation was restored two months after the hail storm.

- ***Banana plants developed an extensive root system with more root hairs which increased surface area enabling absorption of water that was used to carry out more photosynthesis, produced enough food leading to high growth rate.***
- ***Formation of more root hairs enabled active absorption of more mineral salts like nitrates used to form more proteins which enabled growth of new plant tissues to replace damaged ones.***
- ***Banana plants had underground lateral buds which underwent mitotic cell division and specialisation which enabled asexual formation of new suckers.***
- ***The broad leaves increased surface area for more light and carbon dioxide absorption by chlorophyll and stomata respectively. This enabled a high photosynthetic rate forming more food used during plant growth.***
- ***The upright stems provided best positions for optimal light absorption which led to high rate of photosynthesis providing food for growth.***

12. A gardener is concerned about the health of their tomato plants, which are showing signs of poor growth and yellowing of leaves and some leaves have red tips. They suspect an issue with the plant's ability to take up, transport and unitize essential nutrients.

Task

(a) Identify the essential nutrients that are possible causes of this problem.

- **Nitrogen:** Its deficiency causes poor growth and yellowing of older leaves.
- **Phosphorus:** Its deficiency can cause stunted growth and reddish or purplish leaf tips.
- **Potassium:** Its deficiency may lead to yellowing and browning at leaf edges and tips.
- **Magnesium:** Its deficiency leads to yellowing between veins (interveinal chlorosis), especially in older leaves.

(b) Explain how the transport system of plants can result into nutrient imbalance.

- ***The xylem transports water and dissolved mineral nutrients (such as nitrates, phosphates, potassium, and magnesium) from roots to leaves.***
- ***If xylem vessels are damaged, for example by root pests (like nematodes) or stem borers or blocked by pathogens, or affected by drought, the upward movement of minerals is greatly reduced. This leads to nutrient deficiencies in leaves, causing yellowing (chlorosis), red or brown tips, and overall poor growth because minerals are essential for chlorophyll synthesis and normal metabolic activities.***
- ***The phloem, which transports organic food and mobile minerals from leaves to other parts, when disrupted (for example by sap-sucking insects), further worsens nutrient imbalance and weakens plant health.***

(c) Explain to the farmer the steps he can take to ensure proper growth of his plants.

- ***Apply balanced fertilizers with essential nutrients to supply what the plants need for growth.***
- ***Improve soil structure by adding compost or manure to increase aeration and water retention, helping roots absorb nutrients better.***

- ***Water adequately and avoid waterlogging to ensure minerals dissolve for uptake without causing root rot.***
- ***Control root pests and diseases to prevent damage that blocks nutrient and water absorption.***
- ***Monitor leaves regularly for deficiency signs to detect problems early and correct them before growth is affected.***

13. Mr. Kalema planted maize in a cassava garden at the point of tuber formation. When the maize plants were flowering, a heavy hailstorm hit the garden and destroyed all the crops, breaking all the cassava stems. After a month, Mr. Kalema was surprised to see the cassava plants sprouting again, but there were no new maize plants re-growing.

Task:

(a) Identify the plant structures affected by the hailstorm.

- ***Leaves***
- ***Stems***
- ***Maize flowers***

(b) Explain how the normal functioning of the plants was affected by the hailstorm.

- ***The leaves were destroyed, which affected photosynthesis by reducing the surface area for light absorption, resulting in minimal or no food synthesis and stunted growth.***
- ***The stems were broken, which disrupted transport in xylem and phloem, preventing upward movement of water and minerals and blocking translocation of manufactured food to storage and growing regions.***
- ***The flowers (in maize) were destroyed, which impaired sexual reproduction, stopping pollination and fertilization, thereby preventing seed and fruit formation.***
- ***The shoot apices were damaged, which inhibited apical growth, stopping the formation of new shoots and leaves.***

(c) Give reasons for Mr. Kalema's observation after one month.

- ***Cassava sprouted again because it has underground tuberous roots that function as perennating organs, storing reserve food materials (mainly starch) that support regrowth.***
- ***Additionally, cassava stems possess axillary buds at the nodes, which can develop into new shoots when the aerial parts are destroyed.***
- ***In contrast, maize lacks underground storage organs and does not have axillary buds below ground, so it could not regenerate after the stems were damaged.***

14. Mr. Kazimba’s cassava garden was invaded by the neighbour’s goats at the time of tuber formation, consuming and damaging the plants. The owner of the goats has refused to compensate Mr. Kazimba, and Mr. Kazimba is worried that the yields will be poor.

Task:

(a) Identify the plant structures that were affected by the goats.

- ***Leaves***
- ***Stems***

(b) Explain how the goats affected the processes in the cassava plants.

- ***Photosynthesis;*** ***The cassava leaves, which were eaten by the goats, are the sites for photosynthesis. Their removal reduced the surface area for trapping sunlight and eliminated the sites for carbon dioxide entry, which are essential for photosynthesis. The breaking of stems also interrupted the transport of water from the soil to the leaves, hence further reducing photosynthesis.***
- ***Transpiration; The rate of transpiration was greatly reduced since few or no leaves remained to act as sites for this process. The broken stems further interrupted the continuous water column, weakening the transpiration pull.***
- ***Translocation; The damaged stem bark and broken stems destroyed the phloem tissues, hindering or preventing the movement of manufactured food from the leaves to other parts of the plant where it was needed for respiration, growth, and storage.***

(c) Why should Mr. Kazimba be compensated even if the cassava plants were able to grow again?

- ***Food substances that should have been stored in the root tubers were instead used to facilitate growth of new plant parts. This consequently affected both the size and quality of root tubers leading to poor yields hence a need to compensate Mr. Kazimba.***
  The roles of the affected processes are;
  Photosynthesis makes food, stored in tubers, hence increasing the quality and quantity of yields.
  Transpiration allows movement of water up the plant, which is a raw material for photosynthesis.
  Translocation permits movement of food from sites of manufacture to other parts e.g. for growth, storage etc.

15. Jonah planted maize and mixed beans on his plot along a dusty road side. As a way of obtaining good yields, prepared his garden well and planted quality seeds in closely packed columns and rows, applied fertilizers, sprayed to prevent any pests and removed weeds. He planted maize earlier and planted beans later after the maize were already tall. His maize yielded poorly and beans remained stunted with no yields. He is very worried about the out comes yet he spent a lot of money on the garden.
Task.
(a) Describe the causes of the outcomes.

- ***There was closed spacing, growing of the plants very close to each other which caused stiff competition for growth factors like nutrients, light, air required by the plant to grow and carryout photosynthesis.***
- ***There was also a wrong pattern of planting; when the maize plants were planted earlier which led to rapid exhaustion of nutrients in the soil such as Nitrogen, ammonium ions required for proper growth of the plants.***
- ***The garden being close to a dusty road caused the dust to accumulate on the leaves of the plants which reduced on the rate of absorption of light energy by the chlorophyll of the leaves which reduced on the rate of formation of starch by the plants.***
- ***Late planting of the beans caused the beans to be shaded and covered by the already tall long maize plants which reduced the photosynthetic rate of the beans thus stunted growth.***

(b) Advise Jonah on how he can plant the same plants in the same garden in other seasons with minimal losses.

- ***Beans should be planted earlier in the garden or together with the maize since they are leguminous plants with root nodules with Rhizobium that fixes nitrogen to form nitrate ions need by the plants for proper growth.***
- ***Thinning out of some plants especially maize to create more space and light penetration to all plants for efficient photosynthesis to improve yields.***
- ***Trees can be planted alongside the roads to trap some dust from the dusty road in the future and reduce on soil erosion.***
- ***Irrigation to remove dust on leaves and moisture needed for proper germination of seeds.***

16. In the village of Kigungu located in Entebbe, local farmers predominantly cultivate Bananas and Cassava. However, the village recently faced a prolonged dry spell followed by strong winds which brought a significant amount of dust that settled on the leaves and stems of banana and cassava crops. The farmers are worried that if this problem persists, it could lead to severe losses in their harvests.

Task:
a) Identify the life processes affected in the plants.

- ***Photosynthesis***
- ***Gaseous exchange***
- ***Transpiration***
- ***Respiration***

b) Explain

i) how the functioning of these plants was affected.

- ***Dust covering the leaves reduced sunlight reaching chlorophyll, decreasing photosynthesis and lowering food production.***
- ***Dust blocked stomata, reducing carbon dioxide intake and oxygen release, which impaired gaseous exchange.***
- ***Stomatal blockage also limited water loss, disrupting transpiration and thus reducing water and mineral uptake from the roots, by transpiration pull.***
- ***Poor gaseous exchange lowered oxygen availability for respiration, reducing energy supply needed for growth and active transport.***

ii) solutions that the farmers of Kigungu could implement to overcome the challenges posed by dust on their crops.

- ***Regularly spray cassava plants with water to remove dust.***
- ***Use irrigation systems that minimize dust accumulation.***
- ***Plant windbreaks or use row covers to reduce dust settling on crops.***
- ***Mulch around plants to reduce dust stirring up from the soil.***
- ***Consider planting dust-tolerant crop varieties.***

17. Mr. Matovu is a farmer in Kigungu Village. He borrowed money from PDM and used it to plant his beans on a full acre of land in hopes of making profits and paying back the loan. A few weeks later, the beans had sprouted and formed their first foliage leaves that came out of the ground. A few weeks after sprouting, the leaves developed yellowish patches, and some were being eaten by the caterpillars. Matovu's friend Jonah felt bad for his friend and gave him a pesticide to eradicate the pests that later all died after being sprayed. Unfortunately, the leaves remained yellowish and the bean plants showed

retarded growth. And at the end of the season some bean pods were formed and other plants never yielded anything.

Task.

a. Identify

(i) the life processes that were affected within the plant.

- ***Photosynthesis***
- ***Growth***

(ii) the possible measures Mr. Matovu can put in place to prevent such tragedies from happening again next season.

- ***Applying fertilizers containing Nitrogen, magnesium and phosphorus.***
- ***Soil testing to determine the pH and nutrients lacking and apply them accordingly***
- ***Plant disease resistant crop varieties.***
- ***Practicing integrated Pest Management, by using an combination of techniques such as Biological control, crop rotation etc***
- ***Mulching the garden to maintain moisture in the soil.***

(b) Describe the events that occurred within the seeds from the time they were planted to when the first foliage leaves were formed.

- ***During germination, a seed takes in water from the soil by imbibition through the micropyle. This makes the cotyledons swell and the Testa to split.***
- ***The absorbed water activates enzymes, thus leads to breaking of food materials e.g. starch and protein which are stored in the cotyledons or endosperm.***
- ***The soluble food materials are transported to the growing points of the embryo where they are used to provide energy and making of new cells.***
- ***The radicle is the first to emerge, it grows down wards between soil particles, and root hairs develop a short distance from the root cap and start absorbing water and mineral salts.***
- ***Absorption of water from the soil results into increase in the size of the seed and growth of the radicles and plumule which had the apical meristems, producing the first foliage leaves.***

18. Ddembe of recent bought a piece of land. He planted maize and ground nuts at the onset of the rainy season. After some time, the plants were showing stunted growth, having yellow small leaves, while some leaves had fallen off prematurely. On investigation, he found out that plants had very short poorly developed roots. On consultation from the agriculturalist, he was given a chemical which he mixed with water and sprayed on the crops. After two weeks, the plants had improved with many broad long leaves, many long roots and started flowering. Ddembe is very happy.

Task;

a) Identify the plant nutrients that were likely to be present in the chemical.

- ***Nitrogen***
- ***Phosphorus***
- ***Potassium***

b) i. Explain how the above-named nutrients led to the increase in plant yields.

- ***Nitrogen facilitated chlorophyll and protein synthesis, thereby increasing photosynthetic rate and promoting rapid cell division and vegetative growth, resulting in large, dark green leaves.***
- ***Phosphorus stimulated root growth and development and promoted ATP synthesis, thereby enhancing energy transfer, nutrient absorption, and early plant establishment.***
- ***Potassium activated enzymes, regulated stomatal opening, and enhanced protein and carbohydrate synthesis, thereby improving stress resistance, promoting flowering, and supporting fruit development.***

ii) How did the plants overcome the challenges during growth?

- ***Ground nuts have root nodules which harbor Nitrogen fixing bacteria which fix Nitrogen into nitrates used by the plants.***
- ***Presence of meristematic tissues that divided by mitosis enabled Plants to grow taller to obtain sufficient light for photosynthesis.***
- ***Closing of stomata during the day to avoid excessive water loss***
- ***Producing chemicals which discourage herbivores and pests.***
- ***Possession of buds that developed into new leaves***

19. A farmer in Kiziba village used to tie his cow to a mango tree using a rope. Over time, he noticed that the rope had completely removed a ring of bark all around the tree stem at that point, a process known as ringing. Later, he observed that the part of the stem just above the ring became swollen. After several months, the upper parts of the tree started to wither and dry, and eventually, even the lower parts and roots also died, leading to the death of the whole tree.

<u>Task</u>

a) Explain why the part of the tree above the ring initially became swollen.

- ***The removal of the bark completely destroyed the phloem, which is responsible for transporting products of photosynthesis (mainly sucrose and amino acids) from the leaves to the roots and other plant parts. This blockage stopped downward translocation, causing these products to accumulate above the ring. The high solute concentration lowered the water potential of cells above the ring, leading to the movement of water from the xylem into these cells through pit membranes and then into the cytoplasm by osmosis. This water uptake caused cells to swell, resulting in a noticeable swelling of the stem above the ring.***

b) Explain why the upper and lower parts of the tree eventually dried and died.

- ***Over time, the roots died because they could no longer receive products of photosynthesis needed for respiration and growth. Without functional roots, absorption of water and mineral salts from the soil ceased. Consequently, the upper parts suffered from severe water shortage, leading to loss of turgor, wilting, and eventual drying. The lower stem and roots initially survived on stored reserves but eventually died due to the prolonged absence of new food supply, resulting in total plant death.***

c) State the significance of the girdling (ringing) experiment in plant biology.

- ***The experiment demonstrates that the phloem is found in the bark of a tree and is responsible for transporting manufactured food from leaves to roots and other plant parts.***

20. Jane, a passionate farmer has been attending to her potato garden with care. On one fateful day, a sudden hailstorm hit her garden, leaving behind a trail of destruction. She worried about her family's food security and she wonders how she can save the situation. Their delicate leaves are torn, and the stems bear scars from the impact. The once-promising flowers lie scattered on the ground. Jane fears that this damage will affect tuber formation. She knows that potatoes are a staple food in her family's diet, and a poor harvest could lead to hunger and hardship.

Task

(a) Identify the plant structures that were affected by the hailstorms.

- ***Leaves***
- ***Stems***
- ***Flowers***

(b) Explain how the functioning of the plant processes were affected by the hailstorms.

- ***The storm-damaged leaves hence reducing their ability to photosynthesize effectively. This impacted the plant's ability to produce and store energy, which is essential for the growth and development of the tubers.***
- ***The damaged stems may have difficulty in transporting essential nutrients and water from the soil affecting the overall health and turgor of the plant.***
- ***The scattered and damaged flowers resulted in reduced pollination and fertilization.***
- ***The leaves that were hit by the hailstorms are organs for photosynthesis, so there was reduced making of food by the plants. Removal of leaves also denied the plant entry of carbon dioxide which is a raw material of photosynthesis.***
- ***Damaged buds retarded primary growth of the plants.***
- ***Breakage of stems prevented the transport of water from the roots to the leaves through the xylem and also limited translocation of manufactured food from leaves to other parts of the plant due to damaged phloem.***
- ***Extreme coldness from ice stones slowed down enzyme activities in the roots hence affecting root metabolism.***

(c) Explain what Jane can do to overcome this and ensure a reasonable harvest despite the setback and/or also avoid a similar occurrence in the future.

- ***Remove torn and damaged leaves and stems from potato plants. This will encourage new growth and prevent the spread of diseases from the damaged parts to heathy areas of the plant.***
- ***Providing temporary cover to protect plants from further harm. This could involve using hoops and row covers to shield the plants from adverse weather conditions.***
- ***To avoid similar occurrences in the future, Jane can consider setting her potato garden in a location that is less prone to hailstorms or installing structures like hail nets to provide protection during adverse weather conditions.***
- ***Use organic mulch around the base of the plants to retain moisture, regulate soil temperature and protect the roots from extreme coldness by ice stones.***
- ***Growing a variety of food crops to ensure food security and mitigate the effect of poor potato harvests.***

21. Mr. Ali planted beans in his garden having mature sugarcanes. Just before the beans could flower, a heavy hailstorm hit the garden and all his crops were destroyed. after a month, Ali was surprised to see that there were new young sugarcanes growing but no new beans were growing.

Task

a) Identify the plant structures affected by the hailstorm.

- ***Leaves***
- ***Stems and buds***
- ***Flowers***

b) Explain how the hailstorm affected the normal functioning of the crops.

- ***The leaves were destroyed by the hailstorm, which reduced photosynthesis because there was less surface area to absorb sunlight and take in carbon dioxide, leading to decreased production of food (glucose) for growth and energy.***
- ***The leaves were also destroyed, which reduced transpiration due to fewer functional stomata, resulting in decreased water uptake through the xylem (as transpiration pull was reduced) and impaired mineral absorption and cooling.***
- ***The stems with vascular tissues were broken, which disrupted the transport of water, minerals, and food, by interrupting the continuity of xylem and phloem.***
- ***The growing points (apical buds and meristems) were damaged, which stopped growth and development of new organs, by preventing cell division and differentiation.***
- ***The flowers or developing buds were destroyed, which hindered reproduction, by stopping pollination and seed or fruit formation.***

  (c) Explain why Ali did not have to worry about his sugarcanes, but instead get worried about beans.
- ***Ali did not have to worry about his sugarcanes because they are perennial crops with underground vegetative reproductive structures, including rhizomes and basal axillary buds, which store food and can sprout new shoots after the aerial parts are destroyed.***
- ***In contrast, Ali needed to worry about his beans because they are annual crops that lack such vegetative reproductive structures; they rely entirely on their aerial shoots to complete their life cycle, so once these are destroyed, they cannot regenerate or continue to reproduce.***

22. Mr. Kakooza is a prominent farmer in Kazo district. During one rainy season, he hired a piece of land near a swamp to establish a bean plantation and other crops. Unaware that the area was prone to flooding, he cleared and planted seeds. However, only a few seeds germinated and developed into mature plants. The mature plants had small leaves with yellow patches. In an attempt to improve the situation, he added manure to the garden, but he still received poor yields.

Task:

a) Identify the plant processes that were affected in the plants.

- ***Germination***
- ***Photosynthesis***
- ***Respiration***
- ***Transpiration***
- ***Absorption of water and mineral nutrients***
- ***Gaseous exchange***

b) Explain how the affected plant processes led to low yields.

- ***Waterlogged soils become deprived of oxygen, limiting aerobic respiration in seeds and root cells. This reduces the production of ATP, which is essential for germination and root growth, resulting in poor seedling development.***
- ***Reduced root respiration decreases the active uptake of water and mineral ions, especially nitrates and phosphates, which are vital for synthesizing proteins, nucleic acids, and chlorophyll needed for healthy growth.***
- ***Nitrogen deficiency causes chlorosis due to impaired chlorophyll production, which lowers the plant's ability to capture light energy for photosynthesis.***
- ***Reduced photosynthesis leads to decreased glucose production, limiting the energy and building blocks required for cell division, flower formation, and seed development, thereby reducing yield.***
- ***Flooding causes leaching of soluble nutrients like nitrates and potassium from the root zone, making essential minerals less available for absorption and affecting plant metabolism.***
- ***Prolonged waterlogging causes root hypoxia, leading to root rot and cell death. This reduces root surface area and limits the plant's ability to absorb water and minerals.***
- ***Excess water causes stomatal closure because damaged roots absorb less water. This triggers hormonal signals that close the stomata to conserve water but also restrict carbon dioxide intake, reducing photosynthesis.***
- ***Reduced transpiration pull weakens the movement of water and minerals through the xylem, disrupting nutrient transport and cooling, which negatively affects photosynthesis and growth.***
- ***In limited oxygen supply , roots switch to anaerobic respiration, producing toxic substances like ethanol. These damage root cells, further impair nutrient uptake, and slow plant growth, resulting in lower yields.***

c) How were the plants able to grow and produce some yields?

- ***Slightly elevated areas had better drainage and aeration, allowing normal germination and root function.***
- ***Some plants developed aerenchyma tissues, enabling internal oxygen transport to submerged roots.***
- ***Adventitious roots formed above the waterlogged zone, improving oxygen uptake and mineral absorption.***
- ***Occasional dry spells allowed oxygen to re-enter the root zone, restoring respiration and root activity.***
- ***As legumes, beans formed nodules with Rhizobium, fixing nitrogen to support chlorophyll formation and growth.***
- ***Added manure improved soil structure, enhanced drainage, and increased nutrient availability.***
- ***Some plants were naturally flood-tolerant, enabling them to survive and reproduce under low-oxygen conditions.***

23. Mary and Prisca, both planted beans in different parts of their school compound. Mary's plot was under mango trees, while Prisca's plot was near the school kitchen damping site. Mary's plants grew tall with weak stems and pale green leaves, while Prisca's plants were healthy, with strong stems and dark green leaves. After three weeks, Mary noticed that some leaves of her plants had yellow patches and started falling off. Prisca's plants however, flowered and began forming pods earlier.

Task

(a) Identify the processes that were affected in Mary's garden.

- ***Photosynthesis***
- ***Transpiration***
- ***Gaseous exchange***
- ***Protein synthesis***

(b) Explain how the environmental conditions in each plot affected the processes responsible for growth and development of the plants.

- ***In Mary's plot, shading by mango trees reduced light intensity, limiting photosynthesis and chlorophyll synthesis, causing etiolation as the plants elongated stems in an attempt to reach light, producing weak stems and pale leaves. The low availability of essential nutrients also reduced protein synthesis, slowing growth and delaying development.***
- ***In Prisca's plot, nutrients from decomposed organic matter, together with adequate light, supported chlorophyll formation, protein synthesis, and efficient photosynthesis, promoting vigorous growth and early flowering and pod formation.***

(c) State the nutrients that were mostly lacking in Mary's plants and how this affected their development.

- ***Nitrogen: Needed for protein and chlorophyll synthesis; deficiency caused pale leaves, weak stems, and stunted growth.***
- ***Magnesium: Central component of chlorophyll; deficiency led to yellow patches on leaves and reduced photosynthesis.***
- ***Phosphorus: Required for energy transfer, root development, and reproductive growth; deficiency caused poor root growth and delayed flowering and pod formation.***

24. During the recent dry spell, Jane observed that most of the short herbal plants in their garden had few leaves, matured early, produced few flowers and small sized mature fruits containing seeds which fell off before the plants could dry and die, leaving the garden bare. The paspalum in the nearby school disappeared leaving the compound bare. The large trees lost their leaves and flowers and some of their branches and roots dried. However, the green paspalum and the short herbal plants were later observed growing in the school compound and garden respectively and the large trees produced new new leaves upon receiving rains.

Task

a) Identify the processes that were affected in the large trees.

- ***Photosynthesis***
- ***Transpiration***
- ***Respiration***
- ***Absorption of water and mineral salts***
- ***Growth***
- ***Reproduction.***

b) Explain how the normal functioning of the large trees were affected by the dry spell.

- ***The dry soil contained very little water, so roots could not absorb enough to keep cells turgid, causing leaves and branches to wilt and some roots to dry.***
- ***With little water, mineral salts could not dissolve and reach the roots, leading to nutrient deficiency that limited leaf and flower development.***
- ***Shortage of water caused stomata to close, reducing transpiration and slowing the movement of water and minerals within the plant, contributing to drying of branches.***
- ***Closed stomata prevented carbon dioxide from entering the leaves, and lack of water reduced photosynthesis, lowering glucose production needed for growth, repair, and formation of fruits and seeds.***
- ***Lack of water and mineral nutrients prevented cells from dividing and expanding properly, because water keeps cells turgid and nutrients provide materials for new cells, causing stunted growth, shedding of leaves and flowers, and early fruit drop, which disrupted reproduction.***

c) How were the different plants able to survive?

- ***Short herbal plants survived through drought-resistant seeds that remained dormant until rains returned.***
- ***Large trees shed leaves and some branches to reduce surface area for water loss and relied on stored water and nutrients.***
- ***Paspalum survived by maintaining living tissues below ground, which allowed it to regrow quickly when water became available.***
- ***Large trees produced new leaves when rains returned, resuming growth and photosynthesis.***

SELF-TEST ITEMS

25. Mr. Murushid is a renowned farmer in Wakiso district and carries out subsistence farming. He recently acquired a piece of land on a hilly place near a dusty marram road. He prepared his garden well, applied fertilizers and later planted beans and maize. At the time of flowering, he observed that the upper surfaces of all the leaves were covered by dust, turned to dark green and the shoots of the bean plants had developed more flower buds, and the area did not receive rain until the time of harvesting. Mr. Murushid received very poor yields from his garden.

Task

(a) State the processes in plants that were affected by the conditions in the area.

b) Explain how the conditions in the area contributed to the very poor yields in Mr.Murushid's garden.

c) How did some of the plants manage to give some yields despite the conditions?

26. Peter is a rural farmer with an insect species in his maize garden which has just begun to flower. He observed that the maize was having eggs of insects on the leaves and beneath the leaves. The local authorities were invited to visit Peter's maize garden to find out what was affecting his farm. Peter was advised to consider spraying the maize, nevertheless the maize managed to give some yield.

Task.

a) Identify the plant structures affected by the insects in Peter's garden.

b) How did the activities of the maize affect the normal functioning of Peter's maize?

c) Explain how Peter's maize finally managed to give some yield.

27. Ms. Amina is a farmer in Mubende district who recently planted a new high-yield tomato variety. The first few weeks went well, but as the dry season peaked, the afternoons became very hot and dry. Ms. Amina noticed that many tomato plants wilted by mid-afternoon. The leaves began curling at the edges and some started dropping prematurely. Despite regular watering early in the morning, the fruits produced were fewer and smaller than expected, disappointing her plans for sale at the local market.

Tasks:

a) Identify the plant processes affected.

b) Explain how these affected processes led to poor fruit yield.

c) Suggest ways Ms. Amina could improve her tomato yields in future dry seasons.

28. In a community garden project, beans were planted in two sections: one shaded by large mango trees and the other in an open area. After several weeks, the beans in the shaded area grew taller but had pale, yellowish leaves and produced few flowers. In contrast, the beans in the open area were shorter, had darker green leaves, and flowered abundantly. The gardeners noticed the shaded beans seemed weaker but still managed to survive until harvest.

Tasks:

a) Identify the plant processes affected in the shaded beans.

b) Explain why the shaded beans grew tall but had fewer flowers and paler leaves.

c) Describe how the shaded bean plants survived despite poor growth conditions.

29. A farmer in a low-lying area planted beans at the onset of the rainy season. Soon after germination, the field became waterlogged due to prolonged heavy rains. In some parts, seeds failed to sprout, while in others, young plants turned pale yellow, appeared weak, and hardly grew. Weeks later, the rains suddenly stopped, and the same field was hit by a long dry spell. The lower leaves of many plants dried up and fell off. Some plants wilted permanently, but a few remained green and managed to produce small pods. The farmer was disappointed by the harvest and wondered what had gone wrong.

Tasks

a) Identify the plant processes that were affected in the plants.

b) Explain how the affected processes led to poor growth and low yields.

c) How did the plants survive both flooding and drought conditions?

30. In a school gardening project, students planted maize and pumpkins on opposite sides of a compound. The maize, growing in an open sunny area, grew tall with deep green leaves and produced large cobs. In contrast, most of the pumpkin plants, grown near a tall building, remained stunted. Their leaves appeared purple-tinged, and the plants produced few, undersized fruits. Upon observation, the students noticed that the building shaded the pumpkin plot for long hours daily and that the soil there was clayey and poorly drained.

Tasks

a) Identify the plant processes that were likely affected in the pumpkin plot.

b) How did the prevailing conditions interfere with these processes, leading to poor yields?

c) Why were the maize plants less affected despite being in the same compound?

31. Two farmers, A and B, planted equal areas of maize during the same season. Farmer A's garden was next to a busy dusty murram road, while Farmer B's garden was further away in a clean, sheltered area. As the plants grew, Farmer A observed that his maize had pale, dusty leaves, slower growth, and produced fewer and smaller cobs. Surprisingly, Farmer B's maize remained green and vigorous, even though it was occasionally attacked by leaf-eating caterpillars.

Tasks

a) Which plant processes were affected in Farmer A's maize?

b) How did the dusty environment interfere with these processes, leading to poor yields?

c) Why did Farmer B's maize yield better despite pest damage?

ITEM 2 (ELEMENT OF CONSTRUCT 4)

Human physiology.

The learner Appreciates how a human body coordinates various activities and adjust to ensure normal functioning of body systems.

Topics and sub topics examined.

- Coordination
- Homeostasis
- Osmoregulation
- Locomotion

Success criteria

The learner explains/describes how a human body coordinates various activities and adjust to ensure normal functioning of body systems.

It is set on Number 2 in the end of cycle (final) assessment.

32. Frank is a teenager who is in S4. He drinks alcohol and uses other related drugs to feel high. On several encounters, his parents have been counselling him to stay away from drugs. One day as he was boiling milk. He rushed to lift the saucepan that had milk as the milk was about to spill. Even after lifting the hot saucepan, without any insulator, he never felt pain. His grand mother got surprised. After putting the saucepan down, Frank experienced pain and rushed to put his hands in water to cool down.

Task.

(a) Explain

(i) the challenges Frank is likely to face as a teenager.

- ***Addiction to alcohol***
- ***Damage of body organs like the liver***
- ***Mental retardation and loss of memory due to brain damage.***

- ***Imprisonment due to crime or violence***

(ii) Explain the reasons behind his failure to respond to the heat stimuli in the scenario.

- ***Alcohol is a Central Nervous System Depressant that reduces the transmission of pain signals. This is because of the chemicals in alcohol that block the release of neurotransmitters that facilitate movement of an impulse across a synapse to the spinal cord..***
- ***Alcohol activates and stimulates the release of painkillers like endorphins that bind to pain receptors in the brain and spinal cord to reduce pain.***

(b) What advice can you give to Frank and other teenagers so as to be productive members of society.

- ***Seek guidance and counselling in the dangers of alcohol consumption***
- ***Avoid friends/peers that influence him into alcohol consumption***
- ***Engage in productive work like Focusing more on academics to keep him busy.***
- ***Quit Alcohol consumption and go for rehabilitation to recover from addiction.***

33. Kelly is a student in S4 who frequently urinates and feels thirsty. One day while on his way back home, he heard a very loud barking sound from a fierce dog. When he tried to run, his legs felt weak and he couldn't move them. When he forced himself to move he instead fell down. His heart pounded, eyes protruded and his heart beat increased.

Task

a) Explain how Kelly's body coordinated from the time the loud barking sound was heard to the time he wanted to run a way.

- ***Sound waves were trapped by the pinna conducted by the auditory canal to the ear drum which vibrated and transmitted vibrations to the ear ossicles which amplified the vibrations. The oval window vibrated, pressure waves were created in the fluid within the inner ear, sensory cells of the organ of Corti in the cochlea were stimulated, impulses were generated and transmitted via the auditory nerve to brain for interpretation.***
- ***Impulses from the brain were transmitted along the motor neurone to the adrenal glands stimulating them to secrete adrenaline hormone which increased the metabolic rate providing energy needed for running. Increased heart beat rate and breathing rate for faster supply of oxygen to respiring muscles to enable energy production.***

(b) Point out:

(i) his bodily metabolic disorder and explain its causes.

- ***Diabetes mellitus; due to inability to secrete insulin as a result of a malfunctioning pancreas.***
- ***Reduced responsiveness of the target cells to insulin hormone due to presence of fats around the liver cells.***

(ii) Ways how he can manage his health condition.

- ***Taking regular insulin shots or injections to provide insulin which regulates the sugar levels.***
- ***Guidance and counselling from health practitioners on how to handle the situation***
- ***Regular exercises in order to reduce the fat around liver cells.***
- ***Reduce the intake of carbohydrate and fatty foods.***

34. David, who is a regular cigarette smoker, was walking through tall grass on his way from the garden when he suddenly saw a large wasp flying toward his face. He immediately ducked and ran, with his heart beating rapidly and his breathing rate increasing.

Task

(a) Describe the biological events that occurred in David's body to help him detect the wasp and respond rapidly.

- ***Light rays from the wasp entered David's eyes and were focused onto the retina, where photoreceptor cells (rods and cones) were stimulated.***
- ***The receptors converted the light stimulus into nerve impulses, which were transmitted via the optic nerve to the cerebrum of the brain for interpretation. The brain recognized the wasp as a threat and activated the sympathetic nervous system.***
- ***This system stimulated the adrenal medulla to secrete the hormone adrenaline into the bloodstream. Adrenaline increased the heart rate, breathing rate, and glucose release to provide energy for rapid muscle activity.***
- ***The brain also sent motor impulses through motor neurons to the skeletal muscles, causing them to contract, enabling David to duck and run.***
- ***The cerebellum enabled him maintain balance and coordination during movement.***

(b) Explain how cigarette smoking could interfere with the body's ability to respond to such situations.

- ***Cigarette smoke contains nicotine, tar, and carbon monoxide.***
- ***Carbon monoxide binds with haemoglobin, reducing the amount of oxygen transported in the blood. Less oxygen reaches the muscles and brain, reducing the efficiency of the fight-or-flight response.***
- ***Smoking damages the alveoli in the lungs, reducing the surface area for gas exchange, making breathing less effective.***
- ***Nicotine may also cause blood vessel constriction and interfere with nerve function.***
- ***As a result, David may experience reduced stamina, slower reflexes, and poor oxygen - supply during emergencies.***

35. Ms. Zainah, a 60-year old woman who always complains of back and joint pains, enjoys reading news papers especially in the morning hours, though she usually places the papers a distance away from her eyes in order to clearly read the words in it. One day, as she was reading on her table, a cockroach ran over her foot. She quickly jumped, threw the newspaper down, but unfortunately she fractured her leg on landing. She was immediately rushed to hospital and doctors managed her fractured leg appropriately.

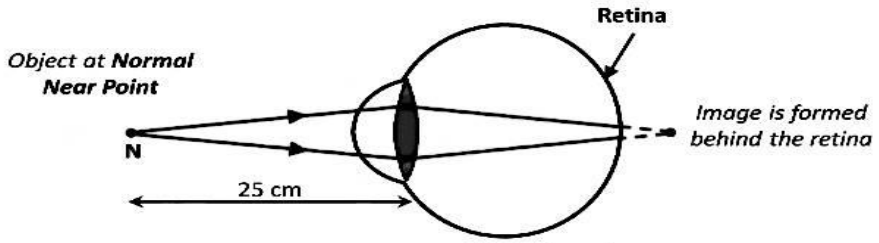
Task

(a) How did the body coordinate leading to the actions of Ms. Zainah?

- ***The touch of the cockroach's legs on her skin stimulated the sensory receptors in her skin; to produce impulses that were sent through the sensory neuron to the relay neuron in the spinal cord, where the impulses were interpreted as dangerous stimulus. The spinal cord in return sent impulses through the motor neuron to the leg muscles, enabling them to contract and relax to bring about movement of the leg, allowing Ms. Zainah to jump off from the cockroach.***

(b) Describe the causes of Ms. Zainah's health challenges.

- ***Zainah has osteoporosis and long sightedness (hypermetropia).***
- ***<u>Osteoporosis is</u> a condition where the rate of bone resorption (breakdown) is high and exceeds bone mineral deposition (formation). It is due a hormonal disorder caused by hyper secretion of parathormone from the parathyroid gland which causes excessive removal of calcium from bones into blood, thus weakening them.***
- ***It is also due to reduced oestrogen levels in blood, which subsequently lowers the rate of bone mineralization; since oestrogen also plays a role in facilitating deposit of calcium into bones, and inhibiting bone resorption. This is common in old women after menopause due to significantly low levels of oestrogen secreted.***
- ***Low calcium and vitamin D intake in the diet; Calcium is important in strengthening bones when deposited to the bone tissue, while vitamin D facilitates Calcium absorption in the gut. Their deficiency results into weak bones and thus osteoporosis.***
- ***<u>Long sightedness</u> is caused by a very weak lens, which cannot sufficiently bend divergent light rays from a nearby object, focusing them behind the retina; but can easily focus parallel rays from a distant object sufficiently to the retina.***



For a Hypermetropia eye, image of an object lying at Normal Near point N (25 cm) is formed **behind the retina**

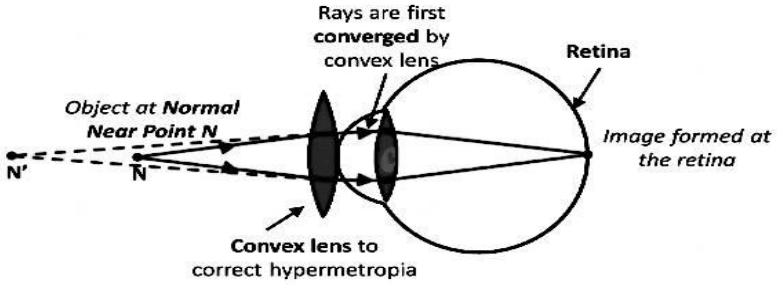
(c) Suggest the strategies to improve her health condition.

<u>Managing osteoporosis</u>

- ***Increase calcium intake by eating milk, cheese, small fish with bones, and green leafy vegetables, because calcium strengthens bones by providing the main mineral component.***
- ***Increase vitamin D intake from fatty fish, egg yolk, fortified milk, and sunlight exposure, because vitamin D increases calcium absorption and supports bone hardening.***
- ***Do weight-bearing and muscle-strengthening exercises like walking, dancing, or lifting weights, because they stimulate bone formation and make bones stronger.***
- ***Avoid smoking and excessive alcohol, because they weaken bones by disrupting hormone balance and slowing bone building.***
- ***Use prescribed medications, because they reduce bone loss or promote new bone formation to keep bones strong.***
- ***Prevent falls at home by using support rails and keeping floors clear, because this reduces fracture risk in weak bones.***
- ***Do regular bone density checks, because they show bone strength and guide treatment.***

<u>Managing long sightedness</u>

- ***Wearing spectacles with converging (convex) lens, to bend divergent light rays from a nearby object before they reach the eye, resulting into easy focusing of the rays to the retina by the eye lens.***



36. Mr. Lodu, a 62-year old officer in a government agency, retired from active duty two years ago, and now he spends much of his time seated at his retirement home. He however, experiences persistent back pain, bone weakness, frequent urination, and feeling thirsty all the time. He also has difficulty in hearing and has resorted to drinking alcohol much of his time.

Task

(a) Identify the health conditions affecting Mr. Lodu.

- ***Osteoporosis***
- ***Diabetes mellitus***
- ***Hearing loss***

(b) Explain the causes of the health conditions affecting Mr. Lodu.

Cause of osteoporosis

- ***Due to aging, testosterone levels decrease, and testosterone normally supports bone strength by stimulating bone formation and maintaining bone mass. When it drops, bone-building activity reduces, making bones weak.***
- ***Low sunlight exposure reduces vitamin D production, which lowers calcium absorption from food and weakens bones.***
- ***Low calcium intake reduces the mineral needed to make bones strong.***
- ***Low blood calcium stimulates parathormone, which increases bone breakdown to release calcium into blood, further weakening bones.***
- ***Reduced physical activity lowers bone strength and makes bones more fragile.***

Cause of Diabetes mellitus

- ***It is due to inability to secrete insulin as a result of a malfunctioning pancreas.***
- ***Reduced responsiveness of the target cells to insulin hormone due to presence of fats around the liver cells.***

Cause of hearing loss

- ***Caused by age-related degeneration of inner ear cells (hair cells), reducing sound detection.***
- ***Alcohol intake damages nerve cells and reduces blood supply to ear structures, worsening hearing.***

- ***Alcohol also affects nerve signaling, further lowering hearing ability.***

(c) Advise Mr. Lodu on how to Improve his health state for a better life in his retirement.

- ***Increase calcium intake by eating milk, cheese, small fish with bones, and green vegetables, because calcium strengthens bones and reduces bone pain.***
- ***Increase vitamin D intake from sunlight exposure, fatty fish, and fortified foods, because vitamin D increases calcium absorption and helps maintain strong bones.***
- ***Reduce alcohol consumption, because alcohol weakens bones, damages nerves, and worsens dehydration.***
- ***Engage in moderate physical activities like walking and light exercises, because movement strengthens bones and improves general health.***
- ***Taking regular insulin shots or injections to provide insulin which regulates the sugar levels.***
- ***Visit a doctor for blood sugar and calcium level checks, because this helps diagnose diabetes or hypercalcemia and guide treatment.***
- ***Ensure a balanced diet with enough water intake, because this maintains overall body function and prevents dehydration.***

37. Arthur smokes cigarettes, Marijuana, cocaine and shisha everyday after work with his friends. During weekends he consumes alot of alcohol. He nolonger has enough money to pay school fees for his children who are appearing malnourished. He beats his wife every time and the wife is in plans of divorcing him. Arthur recently has developed hypertension and diabetes plus other chest problems affecting his breathing rate. He appears weak and other and older than his real age.

Task

(a) Explain the effect of Arthur's life style on

i) Himself.

- ***He appears weak due to low aerobic respiration, less energy is produced due to reduced oxygen carrying capacity of blood caused by increased carboxyhaemoglobin levels in blood.***
- ***He is older than his age because more cells die compared to those that are replaced due to reduced energy production needed for cell division.***
- ***Liver damage due to alcohol consumption that may increase insulin resistance by the liver cells leading to diabetes,. Lung cancer due tosmoking that can lead to death.***
- ***Deposition of fats into the blood vessels after metabolism of the alcohol and constriction of the blood vessels due to presence of nicotine leads to hypertension.***
- ***Imprisonment due to violence and chaos caused by taking marijuana and cocaine.***

ii) His family.

- ***School drop out by his children due to failure for their school fees to be paid.***
- ***Divorce and broken family due to the beatings the wife experiences.***
- ***Family Neglect he is so much attached to his friends than his family***
- ***Domestic violence since he beats his wife.***
- ***Malnourishment due to poverty.***

(b) Explain how Arthur's Situation can be solved.

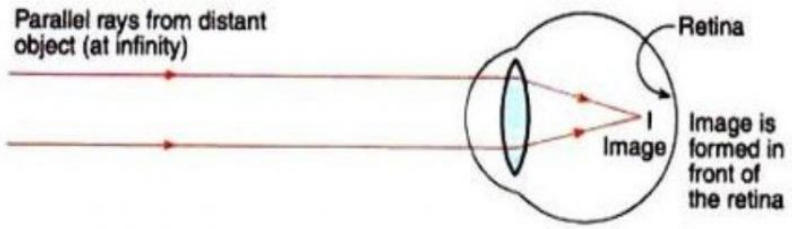
- ***Seek guidance and counselling in the dangers of alcohol consumption***

- ***Avoid friends/peers that influence him into alcohol consumption***
- ***Engage in productive work like Focusing on money making to keep him busy***
- ***Quit Alcohol consumption and go for rehabilitation to recover from addiction.***

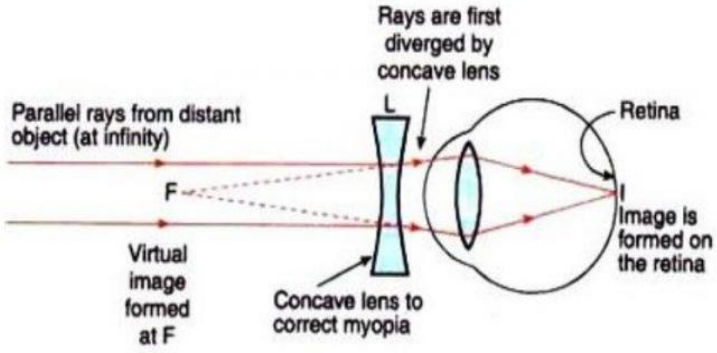
38. Moses is a tall boy, who is bright in class. He however as a result of his friends started taking alcohol and and marijuana which prompted him to always escape from school. One day as the class Teacher was organsing the class, Moses refused to sit at the back, stating that he cannot see clearly on the chalk board when at the back of the class, so he insisted on sitting on the first row of the class.

Tasks;
a) Explain Moses' problem to the teacher that is making him insist on sitting on the first row of the class, clearly pointing out its cause, and how it can be solved.

- ***Short sightedness (Myopia), where near objects can be clearly focused on the retina but not distant objects. Images of distant objects are focused infront of the retina leading to blurred vision of far objects. This is caused by having an abnormally large/long eyeball or having abnormally strong lens/less elastic lens.***



Myopia can be corrected by giving the person spectacles containing a diverging lens to diverge the light rays from a distant object before they reach the eye lens which then strongly refracts them and focuses them to the retina.



(b) State the likely effects of Moses' lifestyle.

- ***Social neglect because substance abuse leads to poor behavior and broken relationships.***
- ***Hypertension as alcohol and drugs interfere with blood pressure regulation.***
- ***Liver and kidney damage since toxins accumulate and destroy these organs.***
- ***Loss of body weight because addiction reduces appetite and nutrient absorption.***
- ***Brain damage causing hallucinations as drugs disrupt normal brain function and sleep patterns.***

(c) Advise Moses on how he can improve his lifestyle and be a good child.

- ***Quit alcohol consumption and smoking marijuana to protect his brain and body organs.***
- ***Join positive peer groups and engage in constructive activities like sports or community work.***
- ***Eat a balanced diet and get enough rest to restore his health.***
- ***Seek counseling or guidance from elders, teachers, or health professionals to overcome addiction.***
- ***Obey his parents and focus on education and personal development to become responsible and respected in society.***

39. Ibrahim is preparing a meal while enjoying a few drinks with friends. After several hours of socializing and consuming alcohol, he decides to warm some milk for his evening tea. As he reaches for the saucepan on the stove, he accidentally touches the side of the hot pan. He doesn't react in anyway but realises later that he got a burn in the process.

Task:

(a) Explain

(i) The key processes and body parts involved in that incidence, including the

roles of sensory receptors, nerves, and the spinal cord.

- ***When Ibrahim touched the hot pan, thermoreceptors and pain receptors in his skin detected excessive heat. These receptors converted the stimuli into nerve impulses which were transmitted via sensory neurons to the spinal cord. The spinal cord acted as a reflex center and immediately sent impulses through motor neurons to the effector muscles in the arm. The muscles contracted and relaxed to withdraw the hand quickly.***
- ***However, because alcohol depresses the central nervous system, it slowed impulse conduction and delayed the reflex action, so Ibrahim did not withdraw his hand promptly and got burnt.***

(ii) The biological problems that arise from Ibrahim's alcohol consumption.

- ***Alcohol slows nerve impulse transmission, reducing sensitivity to pain and heat.***
- ***It affects the cerebellum, impairing balance and coordination.***
- ***Alcohol is metabolized into fat, which can accumulate and block blood vessels, increasing hypertension risk.***
- ***It damages liver cells, causing liver cirrhosis, where normal liver tissue is replaced by fibrous tissue, impairing liver function.***

c. Describe

(i) how the body normally overcomes such challenges through reflex actions.

- ***Thermoreceptors/ pain receptors detect the stimulus, generate impulses which are transmitted along the sensory neurone to the spinal cod via the dorsal root.***
- ***Impulses are transmitted from the sensory neurone to the relay neurone via a synapse, from the relay neurone to the motor neurone via a second synapse.***
- ***Impulses are then transmitted along the motor neurone to the effectors via the ventral root to the effectors.***
- ***The effectors i.e. biceps contract and triceps relax pulling the radius up towards the shoulder bending the arms causing it to withdraw from the hot object.***

(ii)Describe potential strategies or interventions that Ibrahim could take to minimize the risks associated with alcohol consumption in dangerous situations like cooking.

- ***Avoid consuming alcohol before or during activities requiring alertness, such as cooking.***
- ***Seek support to reduce or stop alcohol intake e.g. counseling, support groups.***
- ***Arrange to have assistance when cooking if under the influence.***
- ***Use protective equipment like oven gloves and keep potentially dangerous items out of reach when intoxicated.***

40. Nanyonga, a senior three student normally watches films at the nearby trading centre up to midnight. On her way back home, she saw a fierce looking dog coming towards her. Immediately, she experienced an increase in the rate of heartbeat and breathing. She
picked a stick and beat the dog.
Task
(a) Describe how her body coordinated from the time she saw the dog up to when her arm muscles helped her to beat the dog.

- ***Light rays from the dog are converged and an image is formed onto the retina.***
- ***Photoreceptors are stimulated to generate impulses which are transmitted along the optic nerve to the brain for interpretation.***
  Impulses from the brain are transmitted along the motor neurone to the adrenal glands stimulating them to secrete adrenaline hormone.
- ***Adrenaline hormone increases the heartbeat rate and breathing rate, metabolic rate increases providing energy for the Flexion and Extension so as to beat the dog.***
- ***During flexion, the biceps contracted and the triceps relaxed, pulling the radius and forearmupwards towards the shoulder thus bending the arm, and during the extension, the Triceps contracted and the triceps relaxed pushing the ulna away from the shoulders hence straightening the arm causing the beating of the dog.***

(b) What are the possible
(i) Effects of the student's way of life as described in the scenario above?

- ***Weak body immunity because lack of enough sleep reduces production of protective cells such as white blood cells.***
- ***Hormonal imbalance since sleep controls release of growth and repair hormones.***
- ***Impaired brain function because sleep deprivation affects nerve communication, leading to poor memory and concentration.***
- ***Poor academic performance due to fatigue and reduced concentration.***
- ***Increased risk of accidents and harmful peer influence at night.***
- ***High risk of sexual harassment or rape since moving alone at night makes her vulnerable to attackers.***

(ii) Ways through which the student can be helped to change her lifestyle?

- ***Guidance and counselling to help her realize the health and safety risks of moving at night.***
- ***Avoid bad influence from friends who are luring her into watching films at night/withdraw from bad peer groups.***
- ***Quit watching movies at night to avoid the dangers.***

41. Peter, a secondary school student, finds himself in a risky situation. He is part of a group of peers who engage in smoking, an activity that poses serious health risks. One day, while they are smoking, Peter spots his teacher on patrol duty nearby. Panic sets in, and he runs from the scene. His heart races and he runs as if his life depends on it. When he was stopped, he could not talk because he was breathing heavily and coughing terribly.

Task

(a) Explain the roles played by the body parts involved in coordinating his actions.

Nervous System

- ***Eyes (photoreceptors in the retina) detect the teacher as a visual stimulus and convert it into nerve impulses, which are sent to the brain through the optic nerve.***
- ***Brain receives and interprets the sensory information as danger, makes the decision to run, sends nerve impulses to skeletal muscles to start movement, and activates the hypothalamus to stimulate the adrenal glands via the sympathetic nervous system.***
- ***Motor neurons transmit these nerve impulses from the brain to the muscles involved in movement and breathing.***

Endocrine System

- ***Adrenal glands receive signals from the sympathetic nervous system and secrete adrenaline (epinephrine) into the bloodstream in response to stress.***
- ***Adrenaline increases heart rate and force of contraction, dilates air passages in the lungs, and stimulates the breakdown of glycogen to glucose in muscles, providing quick energy for running.***

Muscular System

- ***Muscles involved in locomotion: leg muscles contract powerfully and repeatedly to produce running movements; arm muscles swing to maintain balance and generate momentum; back and abdominal muscles stabilize the torso for coordinated movement.***
- ***Diaphragm and intercostal muscles contract rapidly and forcefully to increase the size of the chest cavity, allowing deeper and faster breathing.***

Circulatory System

- ***The Heart, increases its rate and force of contraction (tachycardia), helped by adrenaline, to pump more oxygenated blood to active muscles, meeting the higher energy demand during running.***

Respiratory System

- ***The Lungs, increase breathing rate and depth to supply more oxygen to the blood and remove excess carbon dioxide produced by active muscles during intense activity.***

(b) What are the likely effects of Peter's lifestyle?

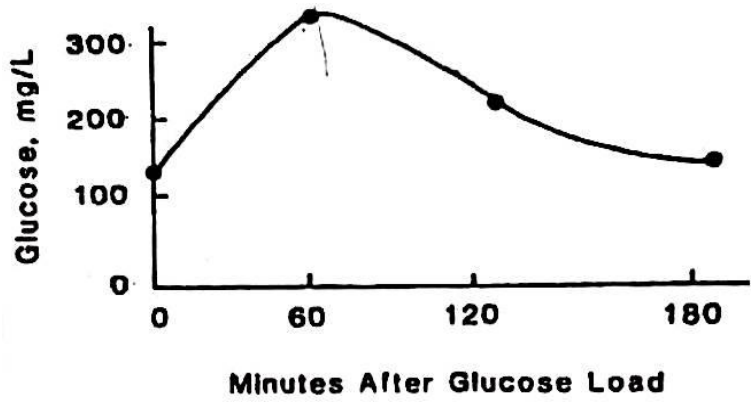
- ***Damage to alveoli, reducing gas exchange and causing breathing difficulties, since tar in smoke destroys their walls.***

- ***Irritation and damage to airways, leading to excess mucus production, chronic coughing, and bronchitis, because chemicals in smoke (like ammonia) inflame the lining, stimulate goblet cells to produce more mucus, coat the walls with tar, and destroy cilia that normally clear mucus.***
- ***Increased risk of lung cancer, because carcinogens in tobacco smoke cause lung cells to mutate and grow uncontrollably.***
- ***Narrowing and hardening of blood vessels (atherosclerosis), reducing blood flow, because nicotine damages vessel walls and encourages fat deposits inside them.***
- ***Increased blood pressure and higher risk of heart disease, because nicotine stimulates the heart and causes vasoconstriction (narrowing of blood vessels).***
- ***Reduced oxygen transport, lowering stamina and fitness, as carbon monoxide from smoke binds to hemoglobin in red blood cells, preventing them from carrying enough oxygen.***
- ***Weakened immune system, making infections more likely, because harmful chemicals reduce the activity of white blood cells.***

(c) How can Peter change his lifestyle for good?

- ***Stop smoking completely, to prevent further lung and heart damage.***
- ***Avoid bad peer groups, to reduce the temptation and pressure to smoke again.***
- ***Do regular physical exercise, to improve lung function and overall body fitness.***
- ***Eat a healthy, balanced diet, to strengthen immunity and support body repair.***
- ***Seek guidance and counseling, to get professional help in overcoming addiction and making better choices.***

42. John fell off a tree as he was climbing to get mangoes for his little sister. He was rushed to the hospital for basic treatment. However, since then, John has had a lot of complications. He urinates frequently, feels thirsty all the time and has a lot of pain in the lower abdomen. He was then taken to a doctor for extended medical checkups. The doctor, suspecting a certain condition, gave him a glucose rich drink (glucose loading) and monitored his blood glucose levels as shown in the graph below.



Task

(a) Comment on the variation of glucose in John's blood with time.

- ***The glucose concentration in blood increased rapidly to the peak immediately after taking glucose, and then decreased gradually with time.***

(b) Identify the organs that could have been affected in John's body.

- ***Pancreas***
- ***Liver***

(c) How did the effect on the organs identified in (b) above lead to John's health condition?

- ***Pancreas: Damage to the beta cells in the islets of Langerhans reduces or stops insulin secretion. Insulin is needed to stimulate body cells to take up glucose from the blood and to promote conversion of glucose to glycogen and to fats for storage. Without insulin, blood glucose remains high, causing diabetes mellitus.***
- ***Liver: Damage to the liver reduces its ability to carry out conversion of glucose to glycogen and to fats. This impairs regulation of blood glucose levels, leading to persistent high blood sugar and contributing to diabetes.***

(d) Suggest possible solutions to John's condition.

- ***Take insulin injections to lower blood glucose levels.***
- ***Follow a controlled diet by reducing simple carbohydrates and eating balanced meals to maintain stable blood sugar levels.***
- ***Do regular exercise to improve muscle glucose uptake and enhance insulin action.***
- ***Avoid alcohol and toxins to protect the pancreas and liver and support normal glucose regulation.***

43. Due to peer influence, Peter started smoking marijuana and drinking of alcohol at a young age. His 70-year old father has for a long time experienced frequent urination, general body weakness, blurred vision, while the mother has a swollen neck, with frequent sharp back pain and bone pain, and cannot see near objects well.

Task

(a) Identify any four organs likely to be affected in the members of the family and state the roles of the identified organs in the body.

- ***Brain: Controls body activities, processes information, enables thinking, memory, and coordination. In Peter, due to marijuana and alcohol affecting brain function.***
- ***Pancreas: Produces insulin to regulate blood sugar levels and digestive enzymes for food breakdown.***
- ***In the Father, frequent urination, weakness, blurred vision suggest diabetes mellitus, which involves pancreatic insulin deficiency.***
- ***Eyes: Enable vision and interpretation of light. In the Father and mother with blurred vision and inability to see near objects.***
- ***Thyroid gland: Produces hormones (thyroxine) that regulate metabolism, growth, and energy use. In the Mother, the swollen neck suggests goitre, caused by a thyroid problem.***

(b) Explain the possible causes of the challenges in the family.

- ***The father likely has diabetes mellitus*****, caused by insufficient insulin production from the pancreas. Without enough insulin, glucose cannot enter body cells efficiently, resulting in high blood sugar. The kidneys filter out excess glucose, which remains in urine. Because glucose**

pulls water by osmosis, this causes frequent urination. The lack of glucose inside cells leads to body weakness, and damage to eye blood vessels causing blurred vision.

- **In the mother, *<u>The swollen neck indicates goitre</u>, caused by iodine deficiency that reduces production of thyroid hormones. Low thyroid hormone levels cause the pituitary gland to release more thyroid-stimulating hormone (TSH), which stimulates enlargement of the thyroid gland. This hormone imbalance disrupts metabolism.***
- ***The mothers <u>bone and back pain</u> may result from <u>osteoporosis</u>, where bones lose strength and become brittle. This can be caused by calcium and vitamin D deficiency or excess parathyroid hormones (hyperparathyroidism), which increase bone breakdown (resorption), leading to bone weakness and pain.***
- ***For Peter, Marijuana and alcohol abuse damage neurons and interfere with neurotransmitter functions in the brain. This results in poor memory, impaired coordination, and reduced judgment.***

(c) Describe the possible solutions on how to manage the health challenges in the family.

<u>Father (diabetes mellitus)</u>

- ***Follow a controlled, balanced diet, especially reducing sugary and fatty foods to help maintain normal blood sugar levels.***
- ***Use insulin injections or other diabetes medication as prescribed by a doctor.***
- ***Engage in regular physical exercise to improve glucose uptake by cells.***
- ***Attend regular medical check-ups to monitor blood sugar and prevent complications.***
- ***Get prompt treatment for eye problems to reduce risk of blindness.***

<u>Mother (goitre, bone and vision problems)</u>

- ***Use iodized salt to increase iodine intake and support normal thyroid hormone production.***
- ***Take calcium and vitamin D supplements to strengthen bones and reduce bone pain.***
- ***Seek medical treatment for the goitre, which may include hormone therapy or surgery if severe.***
- ***Use convex lenses (reading glasses) to correct near vision problems (presbyopia).***
- ***Attend regular health reviews to monitor thyroid function and bone health.***

<u>Peter (substance abuse)</u>

- ***Stop using marijuana and alcohol completely by joining a rehabilitation or counseling program.***
- ***Engage in healthy activities such as sports, jogging, gardening, or music to rebuild brain and body health.***
- ***Join youth support groups to get encouragement from peers in recovery.***
- ***Spend more time with responsible family members and positive friends to avoid bad influence.***
- ***Seek guidance from teachers, religious leaders, or health workers for continuous support.***

44. Kampala-Nateete is such a busy road. Traffic officers often stand for long hours, use mostly their right arm to direct and monitor traffic. At the end of the day, they complain of pain in the upper arm. Due to repetitive movements, monitoring road conditions, Medard a traffic officer on duty was hit by a fast moving motorcycle and broke his pair of glasses that enable him assess driving permits at close range.

Task

(a) Identify the body structures of Kampala-Nateete traffic officers experiencing pain.

- ***Muscles of the upper arm i.e the biceps and triceps due to repeated contractions.***
- ***Shoulder and elbow joints due continuous repetitive movements.***
- ***Tendons and ligaments around the shoulder and elbow joints due to sustained strain.***

(b) Explain how the structures in the arm enable traffic officers perform their duty.

- ***The biceps contracts to flex the elbow while the triceps relaxes, allowing the arm to bend for signaling.***
- ***The triceps contracts to extend the elbow while the biceps relaxes, straightening the arm for clear hand signals.***
- ***The shoulder and elbow joints allow a wide range of arm movements required to direct traffic effectively.***
- ***Tendons and ligaments support and stabilize these joints, enabling smooth, controlled arm motion.***

(c) Explain the causes and remedy of Medard's challenge when hit by a motorcycle.

Causes of Medard's challenges:

- ***The motorcycle accident broke Medard's glasses, which he used to correct long-sightedness (hypermetropia). This occurs when the eyeball is too short or the lens is less elastic, causing images of nearby objects to focus behind the retina and appear blurred.***

Remedies

- ***Replace the broken glasses with convex lenses that converge light rays from the nearby object before reaching the eye lens, so the image focuses correctly on the retina.***
- ***Consult an eye specialist for an updated prescription and to check for any injury.***

(d) Suggest remedy for Kampala-Nateete traffic officers challenges when on duty.

- ***Take regular breaks to rest arm muscles and prevent repetitive strain.***
- ***Use a whistle to give sound signals, reducing the need for continuous arm movements and minimizing muscle and joint strain.***
- ***Perform stretching and strengthening exercises to reduce pain and improve flexibility.***
- ***Use ergonomic supports, such as arm rests or braces, to minimize muscle fatigue.***
- ***Rotate duties among officers to avoid prolonged repetitive movements.***
- ***Use protective gear, such as safety glasses and reflective clothing, to reduce injury risks.***
- ***Provide training on posture and movement techniques to minimize strain.***

45. During the farewell party, some learners of senior four were found hiding in the school orchard smoking. One of them, Richard, confessed they have been doing this since senior one. The teacher is trying to link this to Richard's consistent coughing, difficulty in breathing and the recent medical report on Richard that presents him with high blood pressure, high heart rate and reduced oxygen levels in blood.

Task:

(a) Identify the body organs affected by Richard's behavior.

- ***Lungs***
- ***Heart***
- ***Blood vessels***
- ***Brain***

(b) Explain how the body organs identified were affected and how this affects the body's function.

- ***Lungs: Cigarette smoke contains tar, which sticks to the bronchioles and alveoli, killing cilia and irritating the lining. This causes excess mucus build-up, and the body responds with persistent coughing in attempt to remove the mucus and tar. The blocked airways and damaged alveoli reduce gas exchange, leading to breathing difficulties.***
- ***Heart: Nicotine stimulates the adrenal glands to release adrenaline, which causes narrowing of blood vessels (vasoconstriction) and increases both heart rate and the force of contraction. This raises blood pressure and puts continuous strain on the heart, explaining Richard's high heart rate and high blood pressure.***
- ***Blood vessels: Nicotine causes vasoconstriction, making blood vessels narrower and less elastic. This increases peripheral resistance and raises blood pressure.***
- ***Reduced oxygen delivery: Carbon monoxide binds to hemoglobin, reducing oxygen transport to tissues. Despite increased blood pressure, tissues still receive less oxygen, leading to hypoxia in the body.***
- ***Brain: Nicotine enters the brain and triggers dopamine release, creating pleasure and reinforcement. Repeated exposure causes dependence, making Richard crave more cigarettes and sustain harmful exposure to tar, CO, and nicotine, which worsens his heart, vessel, and lung problems.***

(c) Suggest how schools can prevent the occurrence of such behaviors.

- ***Provide health education to teach students about the harmful effects of smoking on the lungs, heart, and overall health.***
- ***Enforce strict anti-smoking rules and apply consistent consequences for violations.***
- ***Monitor and supervise high-risk areas to prevent students from hiding and smoking.***
- ***Offer counseling and encourage participation in sports or clubs to reduce risky behaviors and peer pressure.***

46. John was persuaded to start smoking marijuana with his friends in the nearby trading centre, which he is now addicted to. One day, during a police hunt, he accidentally stepped on a sharp thorn as he was running away and immediately limped before he could stop to remove it. Although he successfully removed the thorn from his foot, the wound could not easily heal due to a health condition brought about by insufficient insulin hormone production. He has also developed a heavy cough and chest pain due to his addiction.

Task

(a) Explain how John's reaction came about as he was running away.

- ***The pain receptors in John's skin of the foot detected the pain stimulus from the thorn and converted it into nerve impulses.***

- ***The impulses were transmitted through the sensory neuron to the spinal cord for interpretation; where the impulses crossed a synapse and were received by the relay neuron in the spinal cord.***
- ***The impulses travelled through the relay neuron, crossed a synapse and were received by the motor neuron; which transmitted them to leg muscles stimulating them to contract and relax, enabling John to limp, and then remove the thorn from his foot or withdraw the foot from the thorn.***

(b) How can John manage his health conditions to live a better life?

- ***The condition caused by failure of the pancreas to secrete enough insulin is diabetes mellitus.***

Managing diabetes mellitus

- ***Take insulin injections to lower blood glucose levels.***
- ***Follow a controlled diet by reducing simple carbohydrates and eating balanced meals to maintain stable blood sugar levels.***
- ***Do regular exercise to improve muscle glucose uptake and enhance insulin action.***
- ***Avoid alcohol and toxins to protect the pancreas and liver and support normal glucose regulation.***

Managing smoking and addiction

- ***Stop smoking marijuana completely, to prevent further lung, brain and heart damage.***
- ***Avoid bad peer groups, to reduce the temptation and pressure to smoke again.***
- ***Do regular physical exercise, to improve lung function and overall body fitness.***
- ***Eat a healthy, balanced diet, to strengthen immunity and support body repair.***
- ***Seek guidance and counseling, to get professional help in overcoming addiction and making better choices.***
- ***Visit a nearby health unit such as a hospital for check-up to monitor the extent of organ damage and receive appropriate treatment.***

SELF-TEST ITEMS

47. Mr. Ssemukuye is a bee farmer and has been struggling with a swollen neck, legs and longing thirst. These have limited his ability to move to his bee hives and work. He has young daughters who have begun developing breasts and hips and adds he needs to be well to protect them from negative influences. Recently he found them with boys who are known for using drugs and commit crimes and drug trafficking in their town.

Task

a) Identify the healthy conditions affecting Mr. Ssemukuye and explain how they arise in an individual.

b) What challenges do you think Mr. Ssemukuye's daughters will face if they consider continuing with those groups of people.

c) Suggest advice to Mr. Ssemukuye that can be employed to allow him improve his life.

48. In Kampala, Uganda, a group of health researchers conducted a study on the impact of urbanization and modern lifestyle on the health of the population. Through their study, the results indicated a rise in chronic diseases, such as diabetes, hypertension and obesity among the urban population of Kampala.

The factors contributing to the above were identified:
• The sedentary lifestyle, for example lack of physical exercise and sitting for long hours.
• Eating a lot of junk foods.
• Showing a city (much noise and air pollution).
All these lead to a decline in the overall health and well-being of the people.
Task.
a) Explain how the identified factors contribute to the chronic diseases among the urban population as per the study by researchers.

b) Point out the symptoms of any one chronic disease as indicated in the Research Report among the urban population of Kampala.

c) Advise the urban dwellers on how to manage their health conditions and live a better life.

49. Abraham joined a group of young boys who sniff petrol and smoke marijuana frequently. The group became known for crime, violence and causing chaos in trading centres. Abraham and his group members were one day surrounded by policemen who fired gunshots at them. This caused Abraham's heartbeat to increase suddenly and he ran very fast back to their home.

Task

(a) What challenges do you think Abraham may face if he continues associating with such a group?

(b) Describe how Abraham's body coordinated and made him reach home.

(c) Explain how Donald can avoid challenges associated with being in such a group.

50. During a Buganda Kingdom Kabaka health camp in Buddu, Mr. Musoke a 51-year old man who frequently urinates, feels thirsty, and has unexplained weight loss, was diagnosed with a disorder that he was unaware of. On further examination, he admitted that he enjoys sugary drinks, mainly consumes rice and posho but does not exercise. Laboratory tests revealed traces of reducing sugars in Musoke's urine, and this left him worried about the future of his health.

Task

(a) Explain to Mr. Musoke the possible cause of his challenge following the laboratory results.

(b) Suggest measures Musoke can undertake in order to manage the challenges.

ITEM 3 (ELEMENT OF CONSTRUCT 5)

Inheritance of characters and their variation.

The learner Appreciates how traits are inherited in organisms, passed to generations through reproduction and are manifested as organisms grow.
Topics and subtopics examined include

- Genetics [inheritance & variation]
- Cell division
- Reproduction
- Growth & development

Success criteria
The learner explains/describes/ demonstrates how traits are inherited in organisms, passed to generations through reproduction and are manifested as organisms grow.
Set on Number 3 in the End of Cycle (Final) Assessment.

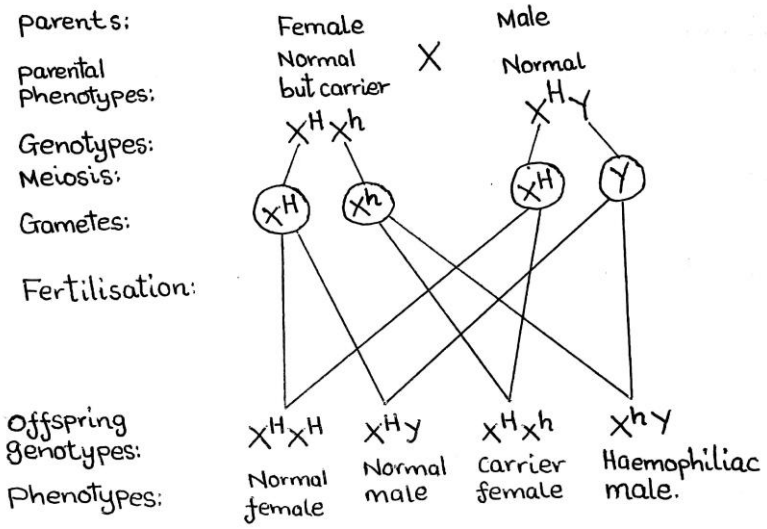
51. In Buliisa, a 20-year-old woman named Anita returned to her village and married a healthy young man. After giving birth to a baby boy, they noticed he bled excessively from small cuts and bruised easily. Remembering that some of Anita's male relatives had similar issues, health workers suspected a hereditary cause and wanted to understand the risk for future children.

Task:

a. i. Using a genetic cross, explain how this condition may have been inherited by the baby.

The mother must have been a carrier for the allele responsible for haemophilia, since the father was normal. The boy child inherited the defective allele from his mother as shown below:
Let H represent an allele for normal blood clotting.

Let h represent an allele for haemophilia



ii. Explain why the baby boy has the condition even though the father is normal.

- ***The baby boy has the condition because he inherited an X chromosome carrying the haemophilia gene from his mother, who is a carrier. The father gave him a normal Y chromosome. Since boys have only one X chromosome, they do not have another normal X to mask the defective gene. As a result, the faulty gene on the single X chromosome is expressed fully, causing haemophilia, even though the father is normal.***

b. What advice would you give Anita and her husband to manage and prevent complications in the family?

- ***Seek regular medical care to manage bleeding and receive clotting factor injections or blood transfusions in case of severe blood loss.***
- ***Avoid activities and sharp objects that may cause injuries to reduce bleeding risks.***

- ***Go for genetic counseling to understand the condition and make informed choices for future pregnancies.***
- ***Create awareness among relatives so that other possible carriers can be identified and supported.***
- ***Provide a balanced diet rich in iron, including green leafy vegetables (like red amaranthus), beetroot, liver, beans, and meat, to help replace lost blood and prevent anemia.***
- ***Maintain good hygiene to prevent infections that can worsen bleeding problems.***

52. An NGO was established in a given community which has high cases of teenage pregnancy and related problems. The NGO has two clear mandates to execute in the community. Namely:
1. Sensitize adolescents on reproductive health, with emphasis on menstrual cycle as a landmark process in adolescent girls.

2. Promote awareness on STI especially HIV/AIDS and promote healthy living.
The NGO does its work through meetings with the youths and other groups to sensitize them in line with the mandates above.
Task
(a) Provide information to explain how the landmark process in the first mandate of the NGO occurs in adolescent girls.

- ***The menstrual cycle is a regular monthly process, lasting about 28 days, that prepares the female body for pregnancy. It has four main phases controlled by changing hormone levels. It begins at puberty and ends at menopause.***

Menstruation Phase (Days 1–5)

- ***The cycle begins with menstruation, where the thickened lining of the uterus (endometrium) breaks down and is shed through the vagina as menstrual blood. This occurs because the hormones estrogen and progesterone are at low levels, which signals the lining to detach.***

Follicular Phase (Days 1–13)

- ***At the same time, the pituitary gland releases follicle-stimulating hormone (FSH). FSH stimulates several ovarian follicles to grow. One follicle becomes dominant and is called the Graafian follicle. This follicle produces increasing amounts of estrogen, which causes the uterine lining to thicken and become rich in blood vessels, preparing it for a possible pregnancy.***

Ovulation (Around Day 14)

- ***When estrogen levels peak, they signal the pituitary gland to release a large amount of luteinizing hormone (LH) in a short time, called the LH surge. This surge causes the Graafian follicle to rupture and release a mature egg from the ovary—a process called ovulation. This is the most fertile time in the cycle.***

Luteal Phase (Days 15–28)

- ***After releasing the egg, the empty follicle transforms into the corpus luteum, which produces progesterone and some estrogen. Progesterone maintains the thickened uterine lining, making it suitable for implantation of a fertilized egg. If fertilization does not occur, the corpus***

luteum breaks down, causing progesterone and estrogen levels to drop. This hormone drop causes the uterine lining to break down, leading to menstruation and the start of a new cycle.

(b) What advises can you give to the community adolescents on how to overcome challenges handled by the NGO in line with the second mandate?

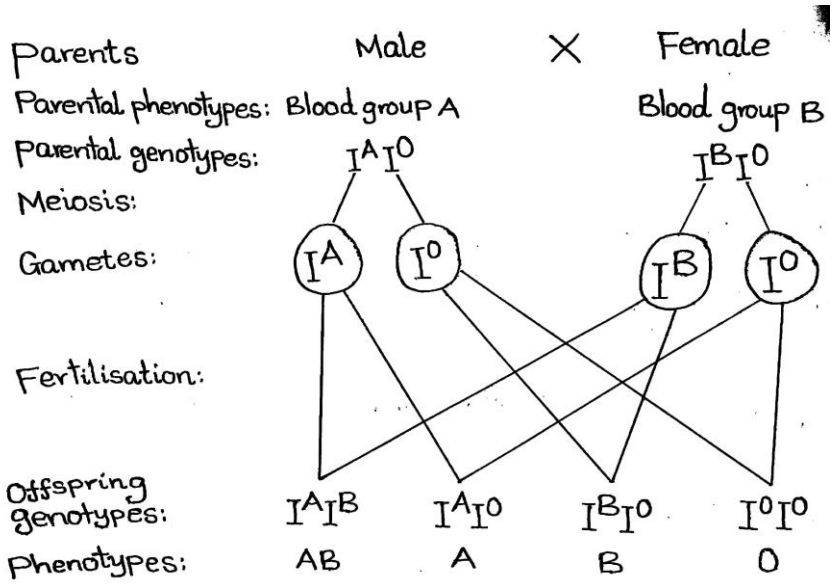
- ***Abstinence to prevent contraction of STIs and early pregnancies that arise from unprotected sexual intercourse.***
- ***Attending guidance and counselling camps to get more information about teenage pregnancy and preventive measures of HIV and teenage pregnancy.***
- ***Girls avoiding moving at night and alone to prevent risks of rape and contraction of STIs and HIV.***
- ***Through sex education to create awareness among adolescents about reproductive health, including how pregnancy occurs and the risks of STIs.***
- ***Avoiding alcohol and drugs so that they remain mentally alert which prevents high risks of sex harassment.***
- ***Avoiding bad peer groups that can lure them into unsafe sexual activities.***

53. In a certain family, a paternity dispute has arisen between a man, Mr. Kasozi, and a woman, Mrs. Kasozi, over their 2-year-old child. Mr. Kabuye denies being the biological father of the child since they have different blood groups while Mrs. Kasozi claims he is the right father. The child's blood type is O, Mrs. Kasozi's blood type is B while Mr. Kasozi's blood type is A. Recently, the child was diagnosed with a bleeder's disease after an injury, where he even needed a blood transfusion but neither of the parents had such a disorder.

Task.

(a) Clearly show to Mr. Kasozi the possibility of being the father of their 2-year-old child basing on the scientific facts of blood groups.

- ***If both Kasozi and his wife are heterozygous for blood group A and B respectively, there is a possibility of him being the father of the child as shown below;***
- **Let I^A be the allele for blood group A**
- **Let I^B be the allele for blood group B**
- **Let I^O be the allele for blood group O**



- ***Since Mr. Kasozi and his wife are capable of producing a child with blood group O, then there's a possibility that the baby belongs to Mr. Kasozi.***

(b) What are the likely effects of the disease discovered in the 2-year-old?

- ***Excessive bleeding leading to anaemia.***
- ***Death due to excessive loss of blood if injured***
- ***Joint pains and joint damage***
- ***Inflammation and swelling in the ankles.***

(c) There was need for a blood transfusion to save the two year child. Both parents were eager and willing to save the child. Explain the possibility of a successful blood transfusion, for the parents to save the child, and give a way forward.

- ***A successful blood transfusion can be done using safe blood. Neither parents has safe blood to donate to the child. This is because the father and the mother have antigens A and B on the surface of their red blood cells which will be recognised by the antibodies a and b present in their child's blood plasma leading to agglutination and death of the child.***
- ***Safe blood can be obtained from an individual who has the same blood group like that of the child to avoid agglutination and haemolysis.***

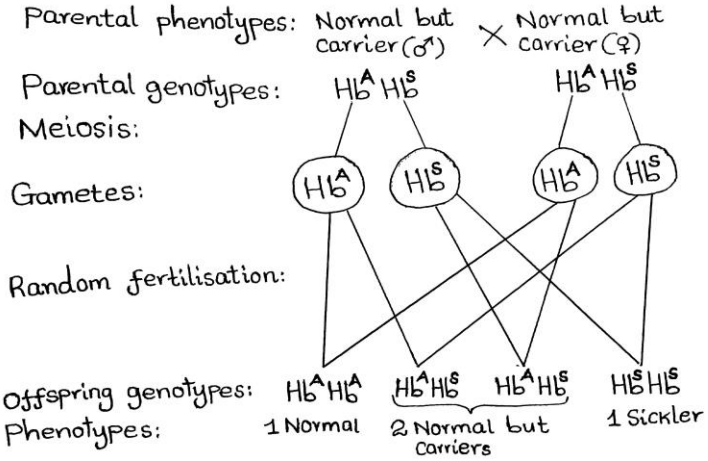
54. Musa was a man of Honor, with a very good job, lived in Munyonyo where he had constructed a very big house where he married and stayed with his new bride. Two years ago Musa's wife got pregnant and gave birth to a son with a very low birth weight, the child experiences pain in his joints, that are always swollen. A medical examination revealed a damaged spleen and low blood count. Musa has sold most of his things to treat his child and feels like God has abandoned him. Musa started living in a grass thatched house in Bwaise with his wife where their son eventually died from leaving them devastated. A year ago, Musa's Wife got pregnant again and experienced a miscarriage. And since then all subsequent pregnancies have been miscarried. Musa is depressed and has sworn to commit suicide. A medical examination revealed a rhesus blood incompatibility causing the miscarriage
Task.

a. Explain.
i. The disorder their first son had.

- ***The son suffered from sickle cell disease, a genetic disorder caused by a mutation on the gene responsible for haemoglobin production, leading to abnormal haemoglobin that makes red blood cells become sickle-shaped at low oxygen concentrations and break down prematurely. It is caused by a recessive allele; thus, their son was homozygous recessive for the sickle cell trait.***

ii. Using a genetic cross show how their son got to have such a disorder.

- ***Both parents were carriers of sickle cell anaemia (had the sickle cell trait) i.e. they were heterozygous for sickle cell anaemia.***
  Let* Hb^A *represent an allele for normal haemoglobin
  Let* Hb^s *represent an allele for abnormal haemoglobin



  Therefore, the son got sickle cell anaemia by inheriting an allele for abnormal haemoglobin from each of the parents.

b. Suggest
i. An explanation for the possible causes of the miscarriage and why their first pregnancy never got miscarried.

- ***The miscarriages are due to Rhesus blood group incompatibility. Musa's wife is Rhesus negative, while Musa is Rhesus positive. In the first pregnancy, the mother's immune system had not yet developed antibodies against Rhesus positive cells, so the baby survived. During delivery, some of the baby's Rhesus positive blood entered the mother's circulation, sensitizing her to produce anti-Rhesus antibodies. In subsequent pregnancies, these antibodies crossed the placenta and destroyed the red blood cells of Rhesus positive fetuses, leading to miscarriages.***

ii. Which advice can you give to Musa so as to deal with the problems his family is facing.

- ***Encourage Musa and his wife to attend regular prenatal visits for close monitoring of the mother's health and the baby's development, early detection of problems, and timely medical support to ensure safer pregnancies and deliveries.***

- ***Advise them to seek genetic counselling to understand the chances of passing on genetic conditions like sickle cell disease, explore carrier testing, and receive guidance on safe reproductive options.***
- ***Emphasize the need for a balanced, nutritious diet during pregnancy to strengthen the mother's immunity, support proper fetal growth, and reduce pregnancy complications.***
- ***Encourage the mother to receive anti-Rhesus (anti-D) injections after delivery or any event of bleeding to prevent antibody formation and protect future pregnancies.***
- ***Promote proper ventilation and good hygiene at home to reduce infections and lower stress on oxygen supply for both the mother and future children.***
- ***Recommend psychological support and counseling services to help Musa and his wife cope with grief, reduce stress, and maintain mental well-being.***
- ***Suggest joining community or faith-based support groups for emotional strength, shared experiences, and practical advice from other parents.***

55. Jane is a secondary school girl, studying in a day school near her home. As a result of bad peer groups, she started drinking alcohol and dodging school. When the school authority tried to trace why Jane was dodging school, they found out that she had a boyfriend in the nearby village, where she would stay, without reaching school. A few months later, Jane started feeling sickly and vomiting. When her parents carried out an HCG urine test, it turned out positive and they were very bitter with her. She was forced to marry her young boy friend by her parents; however she continued with her habits and did not attend antenatal care.

Task:

(a) Explain the events that resulted into the changes in Jane's body from the time she met her boyfriend up to when she started feeling sickly and vomiting.

- ***When the boyfriend inserted an erect penis inside Jane's Vagina, at orgasm, the penis released large number of sperms near the cervix.***
- ***The cervix relaxed and opened up as sperms swum through its opening to the uterus then to the oviduct where fertilization takes place.***
- ***When a sperm got into contact with the egg membrane, it released enzymes from acrosome which broke the egg membrane and enabled the sperm cell penetrate into the cytoplasm of the ovum.***
- ***When the sperm cell enters, the egg membrane becomes thickened to form the fertilization membrane which serves as a barrier preventing the entry of other sperm cells.***
- ***The nuclear membrane of the two gametes breaks down and male nucleus fuse with a female nucleus to form a fertilized egg that later divided by mitosis into a blastocyte that implanted in the endometrium causing pregnancy.***

(b) What are the likely consequences of Jane's lifestyle?

- ***Difficult delivery, because alcohol affects fetal growth and weakens the mother's health, making labor complications more likely.***
- ***Low weight of the baby at birth, due to poor nutrition and reduced oxygen supply caused by alcohol.***
- ***Affected intelligence of her baby at birth, because alcohol interferes with brain development during pregnancy.***

- ***Ill health of her and her baby after birth, since alcohol weakens immunity and failure to attend antenatal care prevents early detection and treatment of health issues.***
- ***Stress, as complications during and after birth can cause emotional and mental strain.***
- ***Family neglect, because alcoholism often leads to poor family relationships and reduced care for the baby.***
- ***Poverty, since money is wasted on alcohol instead of family needs, and poor health increases medical expenses.***
- ***STI infections, because alcohol abuse may lead to risky sexual behavior and missing antenatal care delays testing and treatment.***

(c)Advise Jane on how she can improve her living conditions.

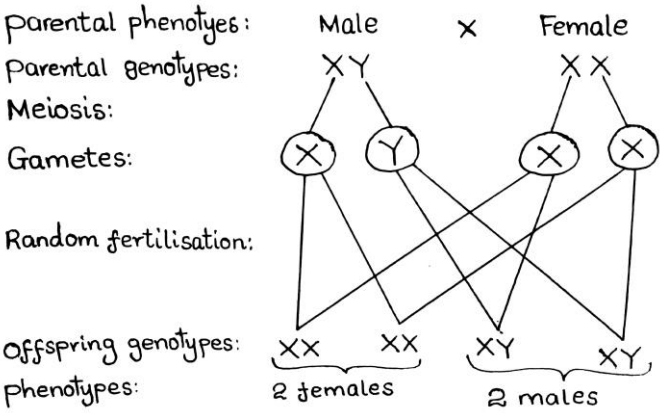
- ***Stop drinking alcohol to protect her health and ensure proper development of her baby.***
- ***Attend regular antenatal visits to monitor the pregnancy and receive necessary health care and advice.***
- ***Eat a balanced and nutritious diet to strengthen her body and support the baby's growth.***
- ***Practice good personal hygiene to prevent infections and promote overall health.***
- ***Seek guidance and counseling to help her make better and healthier life decisions.***
- ***Build supportive relationships with family and community members to reduce stress and improve her well-being.***

56. Mary and Peter had been married for 10 years and have produced five Girls. Peter is very bitter and blames his wife for denying him boys, so he started engaging in extra-marital affairs. After some time, Peter developed an ailment, went to a healthy facility, which after some tests were carried out, it was discovered that he was HIV positive.

Task

(a) Convince Peter, that he is also responsible for the kind of children they have in their marriage.

- ***Females have the genotype XX and produce ova carrying only X chromosomes yet males have the genotype XY and produce sperms which carry either X or Y chromosomes. The sex of the baby is determined by the nature of the sperm that fertilises the ovum i.e. when a sperm carrying the X chromosome fuses with an ovum carrying the X chromosome, a female with the genotype XX is formed. When a sperm carrying the Y chromosome fuses with an ovum carrying the X chromosome, a male with the genotype XY is formed.***



Therefore, males who produce two forms of sperms determine the sex of the baby.

(b) Identify the likely symptoms possessed by Peter, Mary's husband as a result of his health status.

- ***Persistent fever, due to chronic infections.***
- ***Unexplained weight loss, because of increased energy demands and poor absorption.***
- ***Night sweats, as a result of infections or immune activation.***
- ***Prolonged fatigue, caused by reduced immunity and chronic illness.***
- ***Recurrent respiratory infections e.g. frequent cough or pneumonia, due to a weakened immune system.***
- ***Swollen lymph nodes, as the body tries to fight infections.***
- ***Skin rashes, from infections or drug reactions.***

(c) How can Peter manage life with his health status?

- ***Take antiretroviral therapy (ART) consistently to control the virus and protect immunity.***
- ***Eat a balanced and nutritious diet to provide essential nutrients that help strengthen the immune system.***
- ***Go for regular medical check-ups to monitor health, viral load, and detect infections early.***
- ***Exercise moderately to improve body strength and support immune function.***
- ***Avoid risky behaviours like unprotected sex and sharing sharp objects to prevent new infections.***
- ***Seek psychosocial support and counseling to help him cope emotionally and reduce stress.***
- ***Maintain good personal hygiene to prevent opportunistic infections.***
- ***Get enough rest and manage stress to keep immunity strong.***
- ***Avoid smoking and excessive alcohol to prevent further weakening of the immune system.***

57. Sarah who was only fourteen years old and in S.2 was engaged in sexual intercourse with the motorcyclist who used to carry her to school. The man used to have unprotected sex with other women before they had the relationship with Sarah. After six months, Sarah started falling sick frequently, becoming weak and having skin rash as well as general body weakness which has affected her stay at school. After tests, the doctor confirmed that Sarah's illness was due to reduced immunity because of a health condition acquired as a result of her sexual behavior. Recently, Sarah's parents produced her sister who is an albino yet both of their parents have normal skin color. The family is stressed.

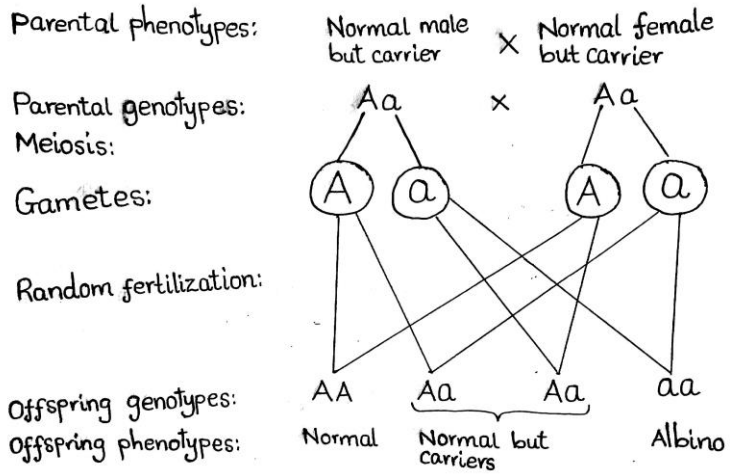
Task

a) Genetically show how the sister's condition came about.

Both parents had the allele for albinism (heterozygous) though they were phenotypically normal. The albino sister inherited the an allele for albism from each parent, as shown below;

Let A represent an allele for normal skin

Let a represent an allele for albinism.



There was a possibility of producing 3 normal children and 1 albino; Therefore the possibility of an albino sister being produced was ¼×100=25%

b) How can Sarah manage the challenges associated with her health condition to live longer?

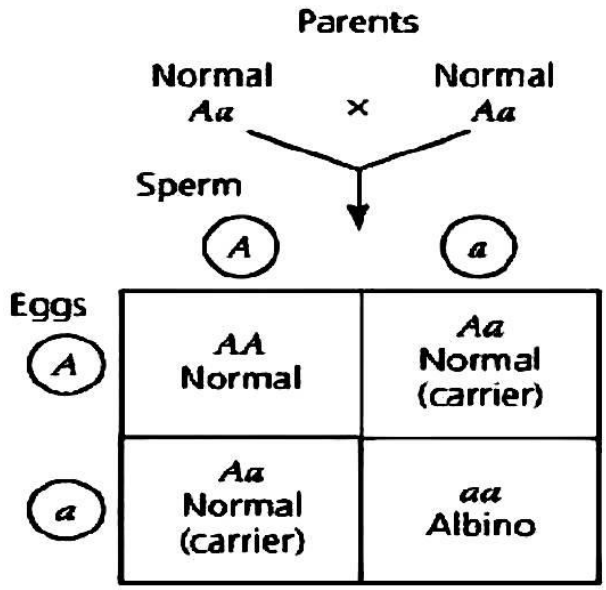
- ***Take antiretroviral therapy (ART) consistently to control the virus and protect immunity.***
- ***Eat a balanced and nutritious diet to provide essential nutrients that help strengthen the immune system.***
- ***Go for regular medical check-ups to monitor health, viral load, and detect infections early.***
- ***Exercise moderately to improve body strength and support immune function.***
- ***Avoid risky behaviours like unprotected sex and sharing sharp objects to prevent new infections.***
- ***Seek psychosocial support and counseling to help him cope emotionally and reduce stress.***
- ***Maintain good personal hygiene to prevent opportunistic infections.***
- ***Get enough rest and manage stress to keep immunity strong.***
- ***Avoid smoking and excessive alcohol to prevent further weakening of the immune system.***

58. Benitah, a 17-year old S.4 girl, with blood group B, got pregnant in 2024, during second term's holiday. When asked the man responsible for the pregnancy, 'Jackson a senior six boy', she replied. But Jackson denied, and due to fear of imprisonment, he escaped from village for 18 months. The baby produced showed pink eyes, a light skin and whitish hair, with blood group O, yet Benitah and Jackson both looked normal and healthy. Jackson is blood group A but when he had that Benitah gave birth to a child completely different from him, Jackson denied that in their entire family, no one has ever given birth to such a child. Benitah is now stranded.

Task

a) Explain the genetic possibilities of Jackson being the father of the baby.

- ***If both Benitah and Jackson are carriers of albinism, it is possible to produce an albino though they look phenotypically normal.***
  Let A represent an allele for normal skin
  Let a represent an allele for albinism.

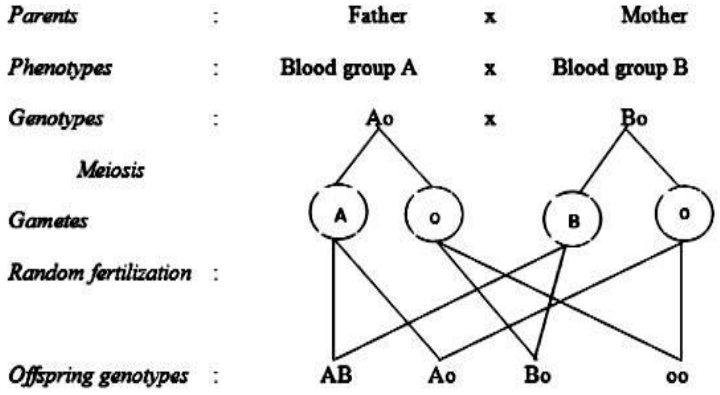


Offspring phenotypes: 3 normal, 1 albino

There's a 25% possibility of producing an albino. i.e ¼×100=25%

For blood groups, it's also possible for Jackson of blood group A and Benitah of blood group B to produce a child of blood group O, as long as both of the parents are heterozygous i.e having the allele for blood group O. Since the allele for blood group O is recessive to that of A and B, it will not be expressed in their presence, in both parents. However if the child inherits one allele for blood group O from both parents, the child will be homozygous recessive (oo), hence having blood type O.

Let A, B and o represent the alleles for blood group A, B and O respectively.



Offspring phenotypes: Blood groups AB, A, B and O

b) Describe the likely challenges to be faced by Jackson, Benitah and their child.

Jackson

- ***Social stigma and rejection from community or peers for impregnating a schoolgirl.***
- ***Legal consequences, including fear of imprisonment due to defilement laws.***

- ***Psychological stress and guilt over denying paternity and escaping.***

Benitah

- ***Stigmatization and discrimination for early pregnancy and giving birth to an albino child.***
- ***Financial difficulties in raising a child as a young mother.***
- ***Interrupted education, affecting her future opportunities.***
- ***Emotional distress from family and community judgment, and Jackson's denial.***

The child

- ***Social discrimination and bullying due to albinism.***
- ***Increased health risks, like high sensitivity to sunlight, skin cancer risk and poor vision.***
- ***Possible identity and acceptance issues, feeling rejected by the father and society.***

c) Suggest possible advice on how other youths can prevent the above challenges, as well as how Benitah's new family can manage their situation.

Advice to other youths

- ***Avoid early sexual relationships and focus on education and future goals.***
- ***Seek reproductive health education, including consequences of unprotected sex.***
- ***Practice self-control and avoid peer pressure, especially during holidays.***
- ***Access to contraceptives and guidance, when appropriate, to prevent unintended pregnancies.***

How to manage the situation

- ***Provide protective clothing like long-sleeved shirts, hats, and sunglasses to shield the skin and eyes from sunlight.***
- ***Use sunscreen to prevent sunburn and reduce skin cancer risk.***
- ***Encourage staying in shade and avoid outdoor activities during strong sunlight hours.***
- ***Take the child for regular eye check-ups to manage vision problems early.***
- ***Give a balanced diet rich in vitamins and minerals to support skin and eye health.***
- ***Teach the child the importance of protecting their skin and eyes.***
- ***Regularly check the skin for wounds or unusual changes and seek medical care promptly.***

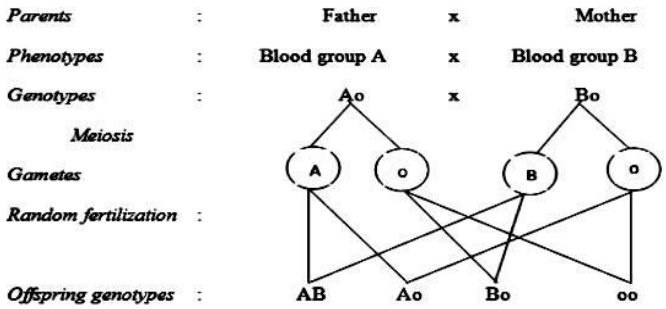
59. A woman has a daughter. There are three men whom she claims might have been the father of the child. The judge in the paternity court orders that all three men, the child, and the mother have blood tests. The results are:
Mother, Type B
Daughter, Type O
Man 1, Type AB
Man 2, Type A
Man 3, Type O.

The mother claims that this proves that Man 3 must be the little girl's father. The judge isn't satisfied, so he asks for the medical records of the people involved. He discovers
that the little girl is colourblind. Men 1 and 2 are also colourblind; Man 3 has normal colour vision, as does the mother.

Task.

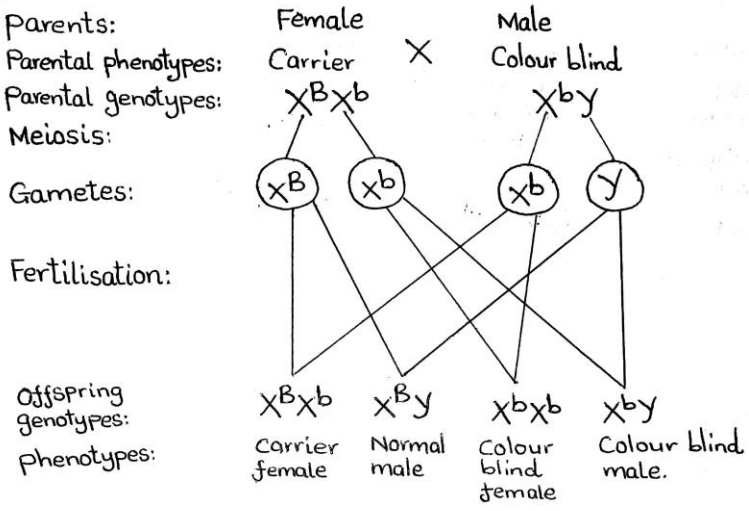
Using your knowledge of Genetics, work out the crosses and determine the rightful biological father of the child.

- ***Considering blood groups first; A man of blood group AB (Man 1) cannot be the father of a child with blood group O because he does not possess an allele for blood group O in his genotype.***
- ***If the woman is heterozygous for blood group B, and man 2 is also heterozygous for blood group A, it's possible for him to be the father of the girl child. Man 3 can also be the possible father of the little girl since he has the allele for blood group O.***
- ***Let A, B and o represent the alleles for blood groups A, B and O respectively.***



Offspring phenotypes: Blood groups AB, A, B and O

- ***From the cross above, we can see that either man 2 or 3 can be the father of the little girl.***
- ***Considering colour blindness; The mother was normal but a carrier for the allele for colour blindness.***
- ***Since the little girl is colour blind, it is evident that her father is also colour blind because she inherited one allele for colour blindness from the father, which is his only X chromosome carrying the defective allele, as shown below;***
  Let B represent the allele for normal colour vision
  Let b represent an allele for colour blindness.



- ***Therefore, Man 2 with blood group A and colour blindness is the father of the little girl.***

60. At a regional sports tournament, a talented 16-year-old girl named Zainah suddenly stops attending training and school. Later, it is discovered that she is pregnant. The coach also notices that several other girls have been missing practices or acting differently, but no one openly talks about what is happening. Some girls are secretly discussing certain medicines they have heard about that "help with monthly problems" or "prevent pregnancy," though they do not have clear information.

Task

(a) Describes the biological events that occur during the cycle highlighted in the scenario.

- ***The menstrual cycle is a regular monthly process, lasting about 28 days, that prepares the female body for pregnancy. It has four main phases controlled by changing hormone levels. It begins at puberty and ends at menopause.***

Menstruation Phase (Days 1–5)

- ***The cycle begins with menstruation, where the thickened lining of the uterus (endometrium) breaks down and is shed through the vagina as menstrual blood. This occurs because the hormones estrogen and progesterone are at low levels, which signals the lining to detach.***

Follicular Phase (Days 1–13)

- ***At the same time, the pituitary gland releases follicle-stimulating hormone (FSH). FSH stimulates several ovarian follicles to grow. One follicle becomes dominant and is called the Graafian follicle. This follicle produces increasing amounts of estrogen, which causes the uterine lining to thicken and become rich in blood vessels, preparing it for a possible pregnancy.***

Ovulation (Around Day 14)

- ***When estrogen levels peak, they signal the pituitary gland to release a large amount of luteinizing hormone (LH) in a short time, called the LH surge. This surge causes the Graafian follicle to rupture and release a mature egg from the ovary—a process called ovulation. This is the most fertile time in the cycle.***

Luteal Phase (Days 15–28)

- ***After releasing the egg, the empty follicle transforms into the corpus luteum, which produces progesterone and some estrogen. Progesterone maintains the thickened uterine lining, making it suitable for implantation of a fertilized egg. If fertilization does not occur, the corpus luteum breaks down, causing progesterone and estrogen levels to drop. This hormone drop causes the uterine lining to break down, leading to menstruation and the start of a new cycle.***

(b) Explain the possible challenges that the girls were facing at their growth stage.

- ***Abdominal pain and cramps, caused by contractions of the uterus as it works to shed the lining during menstruation. This is triggered by chemicals called prostaglandins.***
- ***Weakness and tiredness, due to blood loss during menstruation, which can lower iron levels and reduce energy.***

- ***Mood changes and irritability, caused by fluctuations in hormone levels, especially estrogen and progesterone, which can affect brain chemicals that control mood.***
- ***Breast tenderness, linked to rising and falling levels of estrogen and progesterone before menstruation.***
- ***Headaches, also related to hormonal changes, especially the drop in estrogen levels before menstruation.***
- ***Embarrassment and fear of leakage or odor, due to menstrual flow, especially when proper sanitary materials or private changing spaces are lacking.***
- ***Fear of stigma and teasing, because of cultural beliefs or negative attitudes toward menstruation in some communities.***

(c) What methods should Zainah have used to prevent what happened to her?

Zainah could have used birth control methods such as:

- ***Abstinence: Avoiding sexual intercourse completely, which is the surest way to prevent pregnancy.***
- ***Condoms: Barrier method that prevents sperm from reaching the egg and also protects against infections.***
- ***Oral contraceptive pills: Hormonal pills that prevent ovulation and make the cervical mucus thick, reducing the chance of pregnancy.***
- ***Injectable contraceptives: Hormonal injections given every few months to stop ovulation.***
- ***Implants: Small rods placed under the skin that release hormones to prevent pregnancy for several years.***

61. Milly was 15 years old and in S3, when she was convinced by David to engage in a sexual activity. After one month, she discovered that she was pregnant and decided to go to David for support but David denied being responsible and abandoned her. She later started falling sick more often and on testing she had Hepatitis B and Malaria. She delivered the baby who was mentally retarded, has a short neck, bulging eyes and flat face. The doctor said that the child's mental condition is due to a genetic disorder caused by non disjunction.
Task.
a. Explain
i. how the child's genetic condition comes about.

- ***Down's syndrome is caused by a genetic error called non-disjunction during the formation of gametes in meiosis.***
- ***Normally, during meiosis, each gamete receives one copy of each chromosome. In non-disjunction, chromosome 21 fails to separate properly, so one gamete receives an extra copy of chromosome 21.***
- ***When this abnormal gamete with two copies of chromosome 21 fuses with a normal gamete from the other parent having one copy, the resulting zygote ends up with three copies of chromosome 21 instead of two. This condition is called trisomy 21, which causes Down's syndrome.***
- ***The extra genetic material affects normal development and leads to the characteristic features of Down syndrome, such as mental retardation, flat facial profile, short neck, and other physical changes.***

ii. What are the likely challenges that Milly faced before and after delivery.

Before delivery:

- ***Emotional stress due to unwanted pregnancy and David's denial.***
- ***Health issues like malaria and Hepatitis B infections, which weakened her immunity.***
- ***Social stigma and possible isolation from family and friends.***
- ***Difficulty accessing proper antenatal care.***

After delivery:

- ***Financial burden of caring for a child alone.***
- ***Emotional stress from raising a child with special needs.***
- ***Possible discrimination and social rejection.***
- ***Increased physical exhaustion due to continuous care needs.***
- ***Worry about the child's future and frequent illnesses.***

b. Suggest
i. How Milly can ensure that the child lives a healthy life.

- ***Attend regular medical check-ups to monitor the child's health and development.***
- ***Provide a balanced diet and good hygiene to boost immunity.***
- ***Seek special education and therapy programs to support mental development.***
- ***Join support groups for parents with children with special needs.***
- ***Ensure the child receives all recommended vaccinations and treatments promptly.***

ii. Advise you would give to teenagers outside to prevent what Milly is Passing through.

- ***Avoid early sexual relationships and focus on studies and personal goals.***
- ***Seek accurate information about sexual and reproductive health.***
- ***Understand and use appropriate birth control methods if sexually active (e.g., condoms, pills, abstinence).***
- ***Avoid peer pressure and choose friends who encourage positive behavior.***
- ***Seek guidance from parents, teachers, or health workers when in doubt.***
- ***Get vaccinated against diseases such as Hepatitis B to reduce risk of infections.***

62. Ronald a first year student engaged in a relationship with Phionah, a second year student in one of the prominent universities of Uganda. The following day, Ronald experienced painful urination with pus discharge and swollen testes. Phionah was also diagnosed pregnant. Lacking knowledge of striving with the situation, she opted for abortion but was discouraged by her sibling who knew about her excessive bleeding even with a minor injury. Later, the two got married; In just five years, they had four children; two normal girls and two boys with the mother's condition. Having low finances, Ronald is stressed and challenged with his big family.

Task

(a) Identify the health condition Ronald was diagnosed with and its remedy.

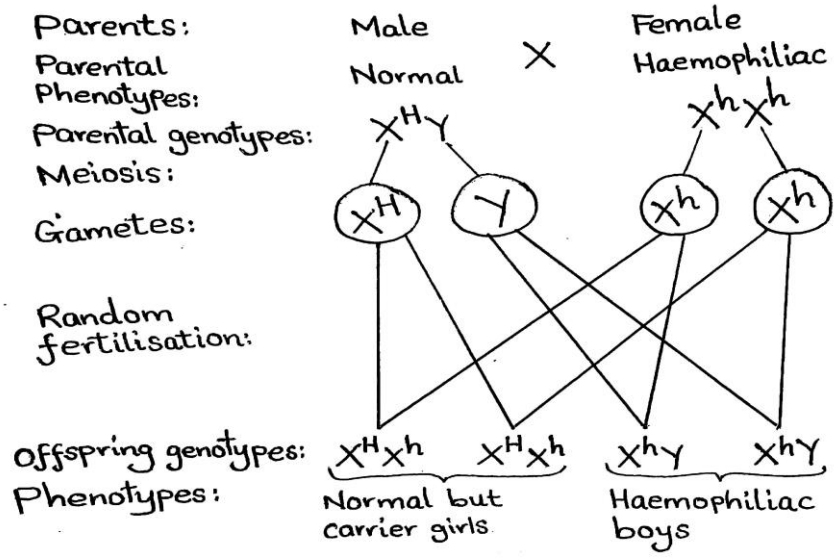
- ***Ronald had Gonorrhoea; a sexually transmitted infection caused by a bacterium called Neisseria gonorrhoeae.***

Remedies:

- ***Use of appropriate antibiotics to eliminate the bacteria.***
- ***Treat both partners simultaneously to prevent reinfection.***
- ***Abstain from sexual activity until fully treated to avoid spreading the infection.***
- ***Practice safe sex in future e.g. using condoms, to prevent recurrence.***

(b) Using genetic symbols and diagrams, show the possibility of Ronald and Phionah's children.

- **Let H represent an allele for normal blood clotting.**
- **Let h represent an allele for haemophilia**



The possibility of getting a haemophiliac boy is ½×100= 50%

The possibility of getting a normal girl is also ½×100= 50%

(c) Advise Ronald on how to overcome his family challenges.

- ***<u>Manage haemophilia in children</u>; by avoiding injuries, using protective gear, attending regular medical check-ups, and seeking clotting factor replacement therapy when necessary.***
- ***<u>Seek family planning services</u>, to help control family size and reduce financial strain.***
- ***<u>Start income-generating projects</u>, to improve family income and meet children's needs.***
- ***<u>Plan and budget with Phionah</u>, to manage available resources more effectively.***
- ***<u>Seek counseling and stress management support</u>, to help him cope emotionally and mentally.***
- ***<u>Join support groups</u>, to share experiences and learn coping strategies from other families.***
- ***<u>Educate children on reproductive health</u>, to prevent future early pregnancies and infections.***

<u>SELF-TEST ITEMS</u>

63. In a recent case in Kigungu, a 16 year old Isabella, influenced by her peers, innocently engaged in sexual acts with several boys and became pregnant with a baby girl. After her baby's birth, it was discovered that the baby has a hereditary disease of excessive bleeding when injured. As news spread, two families were implicated, and Isabella's family sought to identify the baby's biological father to

understand potential hereditary risks and ensure proper support.
Task:

a. i. Using a genetic cross, identify explain how the rightful biological father can be identified.

ii. Describe the processes that led to the pregnancy.
b. Which advice can you give to Isabella and her peers about the dangers of early pregnancy.

64. A couple living with HIV has had three healthy children. Their fourth born however was born with pale skin, white hair and pink eyes. This worried them, since they were both dark-skinned but the doctors advised them to take care of the baby properly, since it was a genetic condition
and so the baby would grow normally as others.
Task
(a) Using genetic symbols, show how the condition in their fourth born came about.

(b) Explain how the couple can
(i) continue living positively with their health status
(ii) take care of their fourth born child.

65. Umar and Zainah have been a happy couple with three healthy boys. When Zainah realized that she was pregnant for a fourth boy, she was very disappointed. She blamed the man for failing to give her a girl, refused to go for antenatal care, started skipping meals, and had thoughts of abortion. This has caused a lot of family distress and Umar is very worried.
TASK.
(a) (i) Using Genetic diagrams, explain to Zainah why she should not lose hope of having a girl child.

(ii) Explain the likely consequences of Zainah's decisions.
(b) Suggest what can be done to help the couple stay healthy and have a safe delivery.

ITEM 4 AND 5 (ELEMENT OF CONSTRUCT 1)

Diversity of organisms & sustainability of natural resources.
The learner Appreciates diversity of organisms & sustainability of natural resources [diversify of organisms, soil, pollution & conservation]

Topics and sub topics to be examined here include:

- Introduction to biology
- Classification
- Cell biology
- Viruses
- Insects
- Flowering plants
- Ecology; Concept of ecology, Food webs & food chains, Community interactions,
- Human & natural environment.
- Soil

Success criteria
The learner explains/describes challenges/problems/effects of destroying the ecosystem give solutions/advice to such challenges and identifies benefits of the ecosystem to the community and to

the environment its self.
Set on Number 4 and 5 in the End Of Cycle paper.

66. Many residents had cleared and constructed residential and commercial buildings and various factories in Lubigi, a large wetland in Kampala. Due to the many environmental challenges brought about by their actions, the National Environmental Management Authority NEMA, has decided to force them out of the area and destroyed all their buildings in order to restore the wetlands and residents are not happy.
Task.
Explain to the residents how their actions have brought about the environmental challenges in Kampala city. Suggest what could be done to avoid such challenges if they were allowed to sustainably live in the area and why is it important for NEMA, to restore the area to its original state.

How the residents' actions caused environmental challenges in Kampala city.

- *Clearing wetlands for buildings and factories destroys natural habitats for fish, amphibians, and unique plant species, reducing biodiversity and lowering fish stocks, which negatively affects fishing and local livelihoods.*
- *Destroying wetlands reduces their natural water purification role, leading to poor water quality and increased cases of waterborne diseases among residents.*
- *Removing wetlands eliminates their ability to absorb and store excess rainwater, causing frequent flooding that damages homes and displaces people.*
- *Cutting down wetland vegetation increases carbon dioxide levels, contributing to global warming, higher local temperatures, and dry, infertile soils that lower agricultural productivity.*
- *Clearing vegetation exposes soils to erosion, leading to the loss of fertile topsoil needed for crops and resulting in reduced agricultural yields.*
- *Discharging untreated chemical and hot water waste from factories into wetlands pollutes water, alters its pH and temperature, and kills aquatic organisms such as fish, reducing their populations.*
- *Releasing excess nutrients from factories into wetlands causes algal blooms; when these algae die and decompose, they deplete oxygen in the water, leading to mass fish deaths and further loss of biodiversity.*
- *Emitting toxic gases from factories into the air causes acid rain, which damages plant leaves, reduces photosynthesis, and leads to lower crop yields.*

Measures to overcome environmental challenges if residents stayed sustainably

- *Strengthen and enforce environmental laws to prevent encroachment and protect wetlands from destructive activities.*
- *Promote sustainable land use practices, such as agroforestry and controlled farming, to maintain soil fertility and support livelihoods.*
- *Rehabilitate degraded wetlands by planting native vegetation and restoring natural water flow channels to revive their ecological functions.*
- *Raise public awareness and involve communities in decision-making to create a sense of ownership and responsibility for wetland conservation.*
- *Provide alternative income-generating activities, such as ecotourism and production of crafts from sustainable wetland resources, to reduce dependence on destructive practices.*

Importance of NEMA restoring the wetland to its original state

- *Restoring wetlands provides raw materials like papyrus reeds, supporting local crafts and livelihoods.*
- *Wetlands purify water before it enters major water bodies, protecting public health and reducing treatment costs.*
- *They support diverse plant and animal species, helping maintain healthy ecosystems and genetic diversity.*
- *Wetlands control floods by absorbing and slowly releasing excess rainwater, protecting settlements from damage.*
- *Vegetation in wetlands prevents soil erosion by holding soil together with roots and ground cover.*
- *They absorb carbon dioxide from the atmosphere, reducing greenhouse gases and helping to combat climate change for a healthier planet.*

67. In a village in Kalungu District, the town residents were complaining of having no market for fish that they had caught in the river. An investor decided to construct a manufacturing factory on the River Banks to provide market for the fish and also get more products from the fish. Fishermen are now complaining about reduced fish, increased cases of respiratory diseases among others.
TASK.
Explain to the locals the challenges the factory may be imposing to life in the river, advise them on the ways to minimise the effects of the challenges and Show them the value of conserving such a natural resource.

Explanation to the locals on the challenges the factory may be imposing to life in the river

- *Discharging untreated chemical wastes into the river alters the water pH and introduces toxins, which kill aquatic organisms such as fish and reduce their numbers, affecting biodiversity and fishermen's livelihoods.*
- *Releasing hot water into the river after cooling factory machines raises water temperatures beyond the tolerance of many aquatic species, leading to their death and further lowering fish populations.*
- *Introducing excess nutrients like nitrates and phosphates from factory waste promotes excessive growth of algae (algal blooms); when these algae decompose, they deplete dissolved oxygen in water, causing mass fish deaths and reducing biodiversity.*
- *Emitting toxic fumes such as sulfur dioxide and nitrogen oxides into the atmosphere causes air pollution; these gases dissolve in rainwater, forming acid rain that damages plant leaves, reduces photosynthesis, and lowers crop yields in surrounding areas.*
- *Heaping soil on riverbanks causes soil erosion; when this soil enters the river, it causes siltation, choking fish habitats and interfering with breeding and feeding grounds, further decreasing fish numbers.*
- *Noise pollution from factory machines disturbs community peace and can force people to migrate to quieter areas, disrupting social and economic activities.*

Ways to minimize the effects of these challenges

- *Treat industrial wastes before releasing them into the river to prevent water pollution and protect aquatic organisms.*
- *Implement afforestation, reforestation, and agroforestry around the river to absorb excess carbon dioxide, reduce air pollution, and prevent soil erosion.*

- *Construct the factory at a safe distance from residential areas to minimize noise pollution and its negative effects on human health and comfort.*
- *Install air filters on chimneys to reduce the release of toxic gases into the atmosphere and limit acid rain formation.*
- *Cool heated water to acceptable temperatures before discharging it into the river to maintain suitable conditions for aquatic life.*

Value of conserving rivers

- *Rivers provide fertile soils along their banks, supporting vegetable and crop farming through irrigation, thus improving food security and household incomes.*
- *They serve as vital sources of clean water for livestock and other domestic uses, sustaining local farming and livelihoods.*
- *Rivers contain sand, an important natural resource used for construction, which generates income for the community when harvested sustainably.*
- *They maintain rich aquatic biodiversity, including fish and other organisms, which are important for food, trade, and ecological balance.*
- *Rivers regulate local climate and maintain the water cycle by providing moisture to the surrounding environment, ensuring continuous rainfall patterns and healthy vegetation.*
- *They create opportunities for eco-tourism and recreation, generating income for local communities and promoting conservation awareness.*

68. In Uganda, the beautiful landscapes are home to diverse ecosystems that provide vital natural resources. However, increasing human activity, such as illegal poaching and deforestation for agricultural purposes, has begun to take a toll on these precious environments. The beautiful forests of Bwindi Impenetrable National Park, a UNESCO World Heritage Site, are known for their rich biodiversity, including endangered species
like the mountain gorilla. Nonetheless, the pressures of land reclamation for farming and unsustainable logging practices have led to significant ecological disruption.
Task.
Explain the effects of such human activities highlighting the natural resources at risk of being affected and what can be done to reverse the effects. Discuss the benefits of preserving such a UNESCO World Heritage Site emphasizing the importance of biodiversity and ecosystem health.

Effects of human activities on natural resources

- *Deforestation caused by clearing large areas of land for farming, settlement, or timber harvesting reduces vegetation cover, leading to increased carbon dioxide in the atmosphere, global warming, higher local temperatures, and ultimately soil infertility due to loss of moisture.*
- *Illegal poaching reduces wildlife populations, leading to loss of biodiversity and extinction of valuable animal species.*
- *Poaching disrupts food chains and food webs, causing imbalances in ecosystems and affecting the survival of other species dependent on those animals.*
- *Reduced animal populations due to poaching lower the attractiveness of wildlife parks to tourists, resulting in decreased tourism revenue and loss of jobs for local communities who depend on tourism.*
- *Targeting culturally significant species, such as the Uganda kob, erodes cultural heritage and weakens traditional values and community identity.*

What can be done to reduce these effects

- *Promote afforestation, reforestation, and agroforestry to restore vegetation cover, sequester carbon dioxide, and improve soil fertility.*
- *Establish and strengthen anti-poaching units by training and equipping rangers to protect wildlife effectively.*
- *Conduct community sensitization campaigns on the importance of conserving animals and the long-term benefits of biodiversity.*
- *Provide alternative employment opportunities in ecotourism and conservation activities to engage local people as active partners in protecting natural resources.*

Benefits of preserving heritage sites like UNESCO sites

- *Protected sites offer beautiful natural scenery that attracts tourists, generating income and providing educational experiences for both locals and foreigners.*
- *They conserve animal and plant species, preventing extinction and maintaining biodiversity for future generations.*
- *Maintaining forested heritage sites improves microclimate conditions, enhancing soil fertility and contributing to better crop yields and harvests.*
- *Preservation of heritage sites maintains cultural and historical values, strengthening national identity and pride.*
- *Conservation-related activities create employment opportunities for local people, including guides, rangers, and service providers.*

69. In Bwera village, farmers continuously grow maize on the same land and burn crop residues after harvest to clear fields quickly. To expand their farms, they have cleared nearby forests. They depend heavily on chemical fertilizers and pesticides to increase their yields faster. Over time, their soils have become hard, less fertile, and increasingly reliant on chemical inputs. During heavy rains, topsoil is washed into nearby streams, making the water muddy and causing siltation. Fish numbers have declined, and downstream rice farmers complain of poor water quality and reduced yields.

Task

a) **Using information from the scenario, explain how the farmers' activities disrupt nutrient recycling, lead to soil infertility, and cause environmental problems in nearby streams.**

- *Growing maize continuously on the same land without including leguminous plants, reduces soil nitrogen levels. Leguminous plants support Rhizobium bacteria in their root nodules, which fix atmospheric nitrogen into ammonium ions that plants can absorb directly or that can be converted into nitrates. Without legumes, this natural source of ammonium ions and nitrates is lost, leading to nitrogen deficiency and reduced soil fertility.*
- *Burning crop residues destroys organic matter that would decompose through ammonification, where decomposers convert organic nitrogen in dead plants into ammonium ions. This reduces the pool of ammonium ions in the soil and prevents humus formation, which stores nutrients and improves soil structure. With less ammonium available, nitrifying bacteria have limited substrate to convert into nitrites and then into nitrates, the main form of nitrogen taken up by most crops. This further reduces nitrogen availability, causing poor plant growth and lower yields.*

- *Clearing forests exposes the topsoil, which is rich in organic nitrogen compounds and soil microbes, to erosion. When this layer is washed away, the soil loses its nitrogen sources and beneficial organisms, becoming compacted and infertile.*
- *Heavy use of chemical fertilizers and pesticides kills soil organisms, including decomposers and nitrogen-fixing bacteria. This disrupts the natural recycling of organic nitrogen into ammonium ions and nitrates, increasing dependence on artificial nitrogen inputs and reducing long-term soil fertility. During heavy rains, eroded soil and excess nitrates from fertilizers are carried into streams. The high nitrate levels lead to rapid algae growth. When algae die and decay, they consume dissolved oxygen, resulting in oxygen depletion and death of fish and other aquatic animals.*
- *Sedimentation from soil particles blocks light, covers fish breeding areas, and destroys aquatic plants. This reduces fish populations and affects water quality for downstream farmers who depend on it for irrigation and rice farming.*

b) Suggest and explain the practices that would help these farmers restore soil fertility and reduce further environmental damage.

- *Crop rotation: Growing different crops in a sequence on the same land especially including legumes in the rotation, replenishes different nutrients in the soil and breaks pest and disease cycles, improving overall soil health and fertility.*
- *Use of organic manure and compost: Adding organic matter improves soil structure, increases water retention, and supports microorganisms involved in decomposing organic material and nutrient recycling.*
- *Agroforestry and planting trees along field edges: Trees reduce wind and water erosion by holding soil with their roots, provide leaf litter that decomposes into humus, and improve microclimate conditions.*
- *Contour planting and terracing: Cultivating along the natural contours of the land reduces the speed of water runoff, minimizes soil erosion, and allows more water to infiltrate into the ground.*
- *Mulching: Covering soil with plant residues or grass reduces evaporation, suppresses weeds, protects the soil surface from rain impact, and adds organic matter as it decomposes.*

70. In order to promote tourism in Murchison falls National Park, the Uganda Wild life Authority decided to increase on the number of lions, and these were transferred from Queen Elizabeth National park to the area. The Lion population in Murchison falls National Park grew bigger, and coincidentally, the numbers of antelopes decreased drastically. With time, the park increasingly became bushy and the game wardens decided to use fire to control the bushes. During periods of burning, thick smoke covered the atmosphere for the greater part of the day. The National wild life body is now concerned over the challenges in the national park.

<u>Task</u>

Explain to the relevant authorities the origin of the problems in Murchison Falls National park, show how they can be worked upon and sensitize them on the relevancy of the natural interactions that go on in such communities.

<u>The origin of the problems in Murchison falls national Park include:</u>

- *Overpopulation of lions caused excessive predation on antelopes, leading to a sharp decline in their numbers and disrupting the natural food chain.*
- *With fewer antelopes grazing, vegetation grew unchecked, resulting in dense bush that altered habitat structure and reduced biodiversity.*

- *Burning to control bushes destroyed essential plant cover and killed decomposers and nitrogen-fixing bacteria, disrupting nutrient cycling and reducing soil fertility.*
- *Smoke from burning released greenhouse gases such as carbon dioxide and nitrogen oxides, which contribute to global warming and acid rain, harming plants, animals, and air quality.*

How the problems can be worked upon

- *Control the lion population to restore balance between predators and prey, allowing antelopes to recover and naturally manage vegetation through grazing.*
- *Replace bush burning with mechanical or manual clearing to protect soil organisms and maintain nutrient cycling.*
- *Implement reforestation with native species to restore habitats, improve soil stability, and enhance ecosystem resilience.*
- *Monitor wildlife populations and vegetation regularly to detect and manage ecological imbalances early.*
- *Promote community involvement in conservation efforts to ensure sustainable management of the park.*
- *Establish alternative food sources or controlled feeding zones to reduce excessive predation pressure on wild herbivores.*

Relevance of natural interactions

- *Predation regulates herbivore populations, preventing overgrazing and maintaining vegetation balance.*
- *Grazing by herbivores controls the growth of fast-growing or dominant plant species, preventing them from outcompeting other plants. This allows a variety of plant species to thrive, promoting plant diversity. In turn, diverse plant communities provide different types of food and shelter for many other animals, supporting a wide range of species and maintaining overall habitat diversity.*
- *Decomposers break down organic matter, recycling nutrients necessary for healthy plant growth and soil fertility.*
- *These interactions sustain biodiversity and ecosystem health, attracting tourists and supporting local economies through eco-tourism.*

71. In the Ugandan localities today, there is a smelly fungus considered to be the heart of the soil. However, there have always existed misconceptions on what living things were. Chinese at times thought of fire, soil, sunlight, among others to be living things. Robert Whittaker an American ecologist saw it wise to put all living things into five broad kingdoms. However, many people today can't tell which organisms belong to each group and why viruses have been put to their own group. Some groups have tiny organisms called microorganisms that some people may not even be aware of, though some use them in food processing, they can't really tell the exact role these microorganisms play in boosting their economic progress.

Task

Design a pager that can be uploaded on the Internet to respond to the above queries and misconceptions.

Clearing Misconceptions About Living Things, Fungi, and Microorganisms.

- *Many people still confuse living and non-living things. True living things carry out life processes: they feed, respire to release energy, grow, respond to stimuli, move, excrete wastes, and reproduce. Non-living things like fire, soil, and sunlight do not show these processes and thus are not considered living.*
- *To help classify all living things clearly, Robert Whittaker, an American ecologist, grouped them into five biological kingdoms: Monera, Protista, Fungi, Plantae, and Animalia.*
- *The kingdom Monera includes bacteria, which are unicellular and prokaryotic; having no true nucleus. They reproduce rapidly by binary fission and play roles in nitrogen fixation and decomposition.*
- *Protista are mainly unicellular eukaryotes with a true nucleus, such as amoeba and some algae. They may be autotrophic; making their own food or heterotrophic; feeding on already manufactured food.*
- *Fungi, including mushrooms, molds, and yeasts, are non-green, lack chlorophyll, and obtain nutrients by absorption (saprophytic or parasitic). The "heart of the soil" fungus seen locally decomposes dead organic matter, enriching the soil with nutrients and thus supporting plant growth.*
- *Plantae are multicellular, have chlorophyll, and make their own food through photosynthesis (autotrophic nutrition). They form the basis of food chains and provide oxygen.*
- *Animalia includes all animals, which are multicellular, lack cell walls, and feed on already made organic food (heterotrophic nutrition). They show active movement and complex behavior.*
- *Viruses, on the other hand, do not fit into any of these kingdoms. They lack cellular structure and do not carry out metabolic processes outside a host. They only reproduce when inside living cells and are thus considered on the borderline between living and non-living things.*
- *Microorganisms (mainly bacteria and fungi) are important though often invisible. Some are used in food processing: bacteria such as lactobacillus ferment milk into yogurt, and yeasts ferment sugars to make bread and alcoholic drinks. Others improve soil fertility through decomposition and nitrogen fixation, boosting agricultural yields and local incomes. Certain bacteria and fungi produce antibiotics like penicillin, supporting the health sector.*

72. An Environment status report was published highlighting the state of affairs at a certain landing site on a fresh water lake. Below are some of the issues highlighted in the report:
The many factories established along the shores of the lake release untreated effluents directly into the lake.
There were no latrines at the busy landing site.
Fishermen use indiscriminate fishing nets to catch fish.
The surround swamp has been taken over by real estate dealers and have raised residential apartments.
The above challenges are believed to cause serious harm to the environment and the human population.
Task:

(a) Explain how the highlighted activities on the landing site will affect the environment and the human population.

- *Untreated effluents cause eutrophication which leads to excessive growth of phytoplankton like algae. This blocks light penetration underneath resulting in reduced visibility to aquatic organisms and limited photosynthesis at the bottom.*

- *Also, the excess phytoplankton die at a high rate and their decomposition by aerobic bacteria consumes a lot of dissolved oxygen causing oxygen depletion, suffocation and death of aerobic organisms and a bad smell.*
- *Lack of latrines leads to defecation in open areas like bushes and the lake which increases risk of water borne disease like cholera, typhoid and dysentery that can cause death especially to children.*
- *Defecation in unsafe places like bushes and nearby forests increases risk of sexual violence like rape to women and young girls in this community.*
- *Indiscriminate fish nets capture young fish and unintended organisms which greatly reduces their population, disrupts feeding relationships and causes death and migration. This reduces food and income in the community.*
- *During construction of residential houses, reclamation of parts of the lake and clearing of nearby forests results in destruction of habitats and breeding grounds which reduces population sizes and biodiversity in the area.*

(b) Suggest
(i) Possible solutions to the above challenges.

- *Effluents should be treated before release to reduce on degree of eutrophication and general pollution of the lake.*
- *Leaders should mobilise for construction of latrines in the community to ensure proper disposal of human wastes which promotes sanitation and safe water in the community.*
- *Water police should be set up to patrol and arrest fishermen using unacceptable fishing nets and a big penalty to the offenders.*
- *Community or district engineers should only approve plans that do not encroach on existing natural vegetation.*

(ii) Why it is important to conserve such ecosystems.

- *The freshwater body provides habitats and breeding grounds for animals which provides a rich source of proteins to the community.*
- *Water bodies are important carbon sinks that absorb a lot of carbon dioxide hence minimise greenhouse effect and global warming.*
- *Conserving the lake will maintain a beautiful scenery that provides recreation activities like swimming, boating, fishing. This boosts tourism and the local economy.*
- *Conservation of the lake provides clean water for human and animal consumption.*
- *Fishing activities on lakes are important economic activities which bring in money that is used to fund community development.*

73. Plants provide one of the most diverse environments for organisms on earth. Unfortunately, they are facing threats due to various factors, causing their populations to reduce at an alarming rate. As a result, the delicate balance of the environment is disturbed, posing a significant challenge a variety of organisms dependent on the plants and the sustainability of natural resources.

Task

Explain how possible threat factors to organisms in the scenario affect long-term survival of variety of living organisms and the natural resources, and provide solutions to ensure environmental sustainability.

How threat factors to plants affect dependent organisms and natural resources.

- *Deforestation removes trees and plant cover, causing loss of habitats for herbivores and other dependent animals. This disrupts food chains, reduces biodiversity, and destabilizes entire ecosystems.*
- *Overgrazing by livestock destroys vegetation, exposes soil to erosion, and reduces soil fertility. This limits regrowth of plants, decreases food supply for herbivores, and affects higher-level consumers.*
- *Pollution, including chemical fertilizers and industrial waste, damages plant tissues and kills beneficial soil microorganisms needed for nutrient recycling. This weakens plant growth and lowers reproduction success.*
- *Acid rain, formed when sulfur dioxide from burning fossil fuels like coal and oil in factories and vehicles and nitrogen oxides from car exhausts and industrial emissions dissolve in rainwater, lowers soil pH, making essential minerals less available to plants. It also damages leaf surfaces, reduces photosynthesis, weakens plants, and increases their susceptibility to diseases and pests.*
- *Climate change disrupts rainfall patterns and temperature, causing droughts or excessive flooding. These extremes hinder seed germination, growth, and flowering, leading to reduced plant populations and loss of food sources for animals.*
- *Invasive species outcompete native plants for water, light, and nutrients. Native plant species decline or disappear, leading to loss of animal species that depend on them and a decrease in genetic diversity.*
- *As plant populations decline, natural resources such as clean air (due to reduced photosynthesis and carbon dioxide absorption), fertile soil (due to erosion and poor organic matter return), and clean water (due to reduced filtration by vegetation) also decline, threatening the long-term survival of many organisms and ecosystem sustainability.*

Solutions to ensure environmental sustainability

- *Reforestation and afforestation to restore plant populations and protect habitats.*
- *Controlled and rotational grazing systems to maintain plant cover and prevent soil degradation.*
- *Strict enforcement against deforestation and illegal harvesting to conserve natural vegetation and biodiversity.*
- *Use of organic and environmentally friendly farming practices to reduce chemical pollution and maintain healthy soil ecosystems.*
- *Removal and control of invasive species to protect native plants and dependent animal life.*
- *Community education and awareness campaigns to promote conservation and sustainable use of resources.*
- *Adoption of climate-smart practices, such as planting drought-resistant plant varieties and conserving water, to help plants survive changing climatic conditions.*

74. Developing countries depend heavily on fossil fuels to run their agricultural activities like fuelling tractors, harvester machines and most motor vehicles. The machines used in agriculture are said to affect soil properties leading to reduced productivity while fuels are associated with causing death of organisms, global warming, climate change and other environmental issues. To reduce the above effects, Uganda banned importing of cars older than 15 years. Despite experts explaining that these cars have old technology that leads to increased release of pollutants like greenhouse gases and smoke, most car dealers believe the government wants to put them out of business.
TASKS.

a) Explain to the car dealers how their cars contribute to the environmental issues talked about in the scenario.

- *Increased greenhouse gases cause higher greenhouse effect with high temperatures that result in death of plants and other organisms.*
- *The old cars release a lot of acidic gases like carbon dioxide and nitrogen oxides which result in acid rain that corrodes or damages leaf surfaces resulting in reduced photosynthesis which limits food in the community.*
- *Smoke contains unburnt carbon particles that reduces visibility in air and can result in accidents to birds and motor vehicles.*
- *The greenhouse gases trap extra heat which causes climate change leading to conditions like melting of ice caps, flooding and high temperatures unfavourable for plant growth.*
- *Increase in greenhouse gases results in ozone depletion which causes penetrating of UV radiation increasing risk of skin cancer.*

  b) Suggest environmentally friendly alternatives that can be used to reduce dependency on the above fuels that are considered harmful to the environment.
- *Importation of brand-new vehicles with advanced technology like catalytic converters to convert environmentally harmful gases to less harmful products.*
- *Importing cars that use clean energy such as electricity and ethanol which do not increase harmful gases in the environment.*
- *Embrace use of public transport which carries many people at once hence reducing consumption of fossil fuels therefore less pollution.*
- *Embrace use of bicycles and walking to minimise fossil fuel consumption and improve physical health.*

75. In Manyonyi village, farmers have been massively clearing the forest for timber and charcoal burning. Over the last two years, there was reduced crop productivity and increased crop destruction due to strong winds, the water level in the community dam has also reduced drastically, and many gullies are now common in their gardens which widen especially during the rainy season.

Task

Explain the environmental problems caused by the farmers' activities. Suggest ways the community can use forest resources sustainably and explain why it is important to conserve natural forests.

Environmental problems caused by the farmers' activities:

- *Clearing forests for timber removes tree roots that bind soil and reduces leaf litter that recycles nutrients, which exposes soil to wind and water, causing erosion, gullies, and loss of fertile topsoil.*
- *Clearing large areas of forest destroys habitats for plants and animals, reducing biodiversity and disturbing the natural interactions and functioning of the ecosystem.*
- *Large-scale deforestation increases atmospheric carbon dioxide as the carbon in trees is released during burning or decay and reduces the forest's ability to absorb carbon dioxide, through photosynthesis, intensifying the greenhouse effect, raising temperatures, and reducing rainfall, which worsens drought and lowers crop productivity.*
- *Charcoal burning removes trees and organic matter, which depletes soil nutrients and reduces microbial activity, lowering soil fertility and crop productivity.*

- *Deforestation eliminates trees that act as windbreaks, allowing strong winds to damage crops and dry out the soil.*
- *Removing trees near water sources reduces infiltration, groundwater storage, and transpiration, which limits local rain formation and lowers water levels in rivers, streams, and the community dam.*

Ways to use forest resources sustainably:

- *Implement agroforestry, integrating trees with crops to maintain soil cover and fertility.*
- *Encourage reforestation and tree planting programs to replace harvested trees.*
- *Educate the community on forest conservation and the benefits of sustainable use.*
- *Practice selective logging to remove only certain trees while maintaining overall forest structure, preserving soil stability, nutrient cycling, and habitat for wildlife.*
- *Promote alternative energy sources, such as solar or biogas, to reduce dependence on timber and charcoal.*

Why it is important to conserve natural forests:

- *Forests prevent soil erosion and maintain soil fertility by anchoring soil with roots, reducing leaching, and returning essential nutrients through decomposed leaf litter.*
- *Forests regulate the water cycle by transpiring water that contributes to rainfall, enhancing infiltration, maintaining soil moisture and groundwater, and ensuring steady flow in rivers and dams.*
- *Forests protect biodiversity by providing habitats and food for a wide range of plants and animals, sustaining ecosystem stability.*
- *Forests act as windbreaks, reducing wind speed over farmland and minimizing damage to crops and soil.*
- *Forests provide sustainable resources such as timber, fruits, and medicines, ensuring their availability for current and future generations.*

76. A new settlement has been built near a wetland. The community generates large amounts of plastic waste, leftover food, and sewage, most of which ends up in the wetland. There are increased malaria cases in the area and many children suffer from diarrhea.

Task

As a student environmental leader, prepare a presentation to deliver to the community addressing ecological dangers posed to the wetland and how proper waste disposal can improve health and the environment.

Protecting Our Wetland for Health and Environment:

- *Good morning everyone. Today, I want to talk about the ecological dangers our wetland faces due to improper waste disposal and how managing waste properly can improve our health and the environment.*

Ecological dangers posed to the wetland:

- ***Water pollution**: Plastic, leftover food, and sewage release harmful chemicals and pathogens into the water, killing aquatic organisms and contaminating water used by the community.*

- ***Mosquito breeding and malaria****: Stagnant, polluted water provides nutrients and shelter for mosquito larvae, increasing mosquito populations and the risk of malaria.*
- ***Waterborne diseases****: Sewage and decomposing food introduce bacteria and viruses into the wetland, which enter humans through contaminated water, causing diarrhea and gastrointestinal infections.*
- ***Loss of biodiversity****: Toxic substances and oxygen depletion from decomposing waste kill fish, plants, and invertebrates, disrupting predator-prey relationships and species interactions.*
- ***Eutrophication****: Excess nutrients from sewage and food waste stimulate algal blooms, which reduce oxygen in the water, suffocating aquatic organisms and affecting nutrient availability and energy transfer in the wetland.*

Benefits of proper waste disposal:

- ***Improves human health****: Collecting and safely disposing of plastic in bins or recycling prevents water contamination, reducing malaria, diarrhea, and other waterborne diseases.*
- ***Protects the wetland ecosystem****: Treating sewage, composting food waste, and avoiding dumping plastic maintain water quality, support aquatic life, and preserve plant and animal habitats.*
- ***Prevents flooding and waterlogging****: Regularly clearing solid waste from drainage channels and wetland edges ensures water flows freely, reducing flooding risks.*
- ***Promotes sustainable community practices****: Recycling plastics, composting organic waste, and properly treating sewage encourages responsible resource use and reduces environmental harm.*
- ***Improves wetland use for the community****: Keeping the wetland clean and free of waste creates a safe and pleasant environment for activities such as fishing, collecting water, walking along the wetland, and children's educational visits.*
- *In a nutshell, proper waste disposal protects our wetland, reduces diseases, and supports wildlife. Let us all take responsibility by managing waste carefully, keeping our wetland clean, and ensuring a healthy and safe environment for ourselves and future generations.*

77. A certain swamp had thick vegetation before Isaac cleared a big part of it to grow only rice on a large scale. He puts poison in the garden to kill rats and other pests, apply artificial fertilizers to make the soil fertile and dig large water channels to direct water away from their farms. After several seasons, challenges have come up such as rapid growth of new kinds of weeds in the swamp, invasion of their homes by monkeys, reduced catch of mudfish, and flooding is now common and reduction in crop yields.

Task

(a) Explain how Isaac's actions caused the challenges.

- *The swamp vegetation provided habitats and food for animals such as monkeys; clearing and draining it destroyed these habitats, forcing the monkeys to invade people's homes in search of food and shelter.*
- *The swamp served as a breeding and feeding ground for mudfish; draining it destroyed these sites and lowered water quality, leading to reduced fish populations and low catches.*
- *Wetlands naturally absorb and store excess rainwater; draining them removed this buffering capacity, so rainwater now accumulates rapidly, causing frequent floods.*

- *Clearing wetland vegetation exposed soil to direct sunlight and erosion, which depleted organic matter and nutrients, leading to reduced soil fertility and low agricultural yields.*
- *The poison used to kill rats and pests was non-selective, killing beneficial soil organisms such as earthworms and decomposers that recycle nutrients and improve aeration, thereby reducing soil fertility and crop productivity.*
- *Continuous application of artificial fertilizers altered soil pH and mineral balance, making the soil unsuitable for many native plants and promoting the growth of invasive weeds that tolerate poor conditions.*

(b) How can the challenges be overcome?

- *Replanting and conserving wetland vegetation to restore habitats and increase water absorption.*
- *Constructing controlled water channels while leaving sections of the swamp undrained to reduce flooding and support mudfish breeding.*
- *Using organic manure and practicing crop rotation to improve soil fertility and sustain yields.*
- *Applying integrated pest management such as natural predators, crop rotation and selective pesticides to control pests without harming useful organisms.*
- *Reducing excessive use of artificial fertilizers and encouraging compost and other natural soil improvers to maintain soil pH and suppress invasive weeds.*

78. During road construction project, the thick vegetation on a nearby hill was cleared in order to carry out quarrying of the rock to obtain gravel. Motorists have continued to use the road as it is being constructed and this produce a lot of dust. The residents have observed that many deep gulleys have been formed on the Hill slopes, crop yields on the road sides have reduced, wild animals are severally destroying people's crops and incidences of strong winds are now common.

<u>Task</u>

a) Explain the cause of the challenges being experienced by the residents.

- *Clearing vegetation removed plant cover that held the soil together with roots, leaving the hill slopes exposed to erosion, leading to formation of deep gullies.*
- *Loss of vegetation reduced organic matter and water-holding capacity of the soil; this made soils dry, less fertile, and unable to support high crop yields along the roadsides.*
- *Quarrying and vegetation clearing destroyed natural habitats and food sources for wild animals, forcing them to migrate into people's gardens in search of food, where they end up destroying crops.*
- *Vegetation previously acted as a windbreak; its removal exposed the area, increasing the frequency and intensity of strong winds.*
- *Dust raised by moving vehicles and road construction settles on crop leaves, clogging stomata and blocking light, which reduces photosynthesis and lowers crop yields.*

b) Why was it important to keep the hill undisturbed?

- *The vegetation would have protected the soil against erosion, preventing loss of topsoil and formation of gullies.*
- *Roots and organic matter from plants would have maintained soil fertility and moisture, supporting healthy crop growth.*

- *The hill vegetation provided habitats and food for wild animals, keeping them away from people's gardens.*
- *Trees and shrubs acted as windbreaks, reducing the occurrence of strong winds.*
- *Vegetation cover minimized dust pollution, ensuring crop leaves remained clean for normal photosynthesis.*

SELF-TEST ITEMS

79. A chemical factory was established on a large river bank, with a view that it needs constant supply of water for its machinery and activities. Overtime, the river developed a lot of algal blooms, and the fisher men complained of dwindling numbers of fish species previously caught in large numbers. It was also noted that during the establishment of the factory, a lot of soil was heaped along the river bank, and so a lot of deposition goes on into the river. Environmentalists have warned the government about pending dangers especially during rainy seasons.
Task

Explain to the locals the challenges the factory may be imposing to life in the river, advise them on the ways to minimise the effects of the challenges and Show them the value of conserving such a natural resource.

80. Mr. Mukasa cleared a forest along the slopes of a hill that had fertile soils to extend his farm for growing maize. After several years of planting maize on his farm, the maize plants planted started to grow slowly with yellow leaves which greatly reduced the maize yields. Yields are poorer at the hill top than in the valley. Also, residents of this village use the valley of Mr. Mukasa's farm for dumping plastic waste bottles and used polythene bags which has caused more challenges especially in the streams found in the valley.
Task
Explain the likely effects of the actions of Mr. Mukasa and the residents of his village and suggest possible ways these effects can be overcome. What is the importance of conservation of valleys?

81. Forty years ago, Banda was a natural swamp with numerous papyrus plants, reptile species and several birds. Over time, people started constructing homes within the wetland until it became a township. However, residents still face a number of challenges both during wet and dry seasons and all these are attributed to the fact that the natural swamp is no longer in existence.

Task:

Explain the problems in Banda, suggest how the residents can overcome them, and show them the value of conserving the natural environment.

82. In Lukaya Town Council, swamps have been cleared for Agriculture, cattle farmlands and sand mining. The town residents are dumping wastes in sewage channels, burning rubbish and polythene and are not concerned of the effects they are causing. The Mayor Mr. Jozin and the town clerk Mrs Joy have sensitized the mass about the dangers of such practices but all in Vain. In a recent radio talk show, Mr. Jozin quoted and said "the Earth has enough resources for our need, but not for our greed. Conserving the environment is a state of harmony between men and Land."

Task.
Explain to the town residents the environmental problems likely addressed by the town Mayor and the town Clerk. and how they can be solved. Explain why the village should

conserve the natural resources in the swamps.

83. As a result of a civil war in one of the countries neighbouring Uganda, many people entered Uganda as refugees. The local authority decided to settle the refugees on a piece of land, part of which was covered by a forest reserve next to a swamp. Several challenges arose in the community.
Task
Explain to the community how the environmental challenges came about. Advise them on how to minimize effects of the challenges and show the value of conserving the environment in the area.

84. Mr. Ibrahim had a piece of land with many shrubs and indigenous trees. He cleared the land in order to grow maize on a large scale. In addition, he destroyed all anthills with chemicals because he feared that termites would attack his maize garden. These caused many challenges to the environment.

Task

Explain;

(a) to Mr. Ibrahim the challenges he caused to the environment.

(b) why it was important for Mr. Ibrahim to conserve his environment.

85. A hilly place previously covered with thick vegetation has recently been dominated by many activities which include, timber cutting, charcoal burning, rearing of cattle and crop gardening. Farmers practice bush burning in preparation for planting and also dig up and down the slopes of the hill. Incidences of strong wind, mudslides, and flooding of gardens in the valleys have become common in the area.

Task

Explain

(a) how the different activities have caused challenges in the area and how they can be overcome.

(b) why the community should conserve the hill.

86. As more industries are established near Lake Victoria, more industrial wastes are increasingly drained into the lake. This result into several changes occuring in the lake and affecting interdependence of various organisms in the water and the land, hindering their survival and various human activities which consequently hinder social economic development. As one of the SDGs by 2030.

TASK;

Explain why various changes occurring in the lake hinder social economic growth and provide suitable solutions towards achievement of the above goal as per vision 2030. Of what benefit is it for Uganda to conserve the natural resources affected by these industries?

ITEM 6 AND 7 (ELEMENT OF CONSTRUCT 3)

Animal biology (zoology).

The learner Understands how mammals (animals) obtain & use nutrients to meet their energy requirements during which raw materials and products are carried to & from different organs involved.
Topics and subtopics examined include.

- Nutrition in animals
- Transport in animals
- Respiration in animals
- Gaseous exchange in animals
- Excretion in animals
- Growth & development in animals

Success criteria

The learner explains/describes roles of structures/processes/concepts involved and explains or describes the symptoms/causes/effects of disorders/problems.

Set on Number 6 or 7 in the question paper

87. After a morning heavy carbohydrate meal, Mwesigwa, a male athlete started to warm up in preparation for the competition in long races. He competed favorably, but towards the end, he developed muscle cramps and was breathing heavily. Nonetheless he endured and finally won the race. After finishing, his heavy breathing continued, while the muscle cramp progressively receded. He even managed to walk back home from where he took another meal.

Task

Explain how Mwesigwa's body utilized the morning meal to enable him win the competition, analyze the challenges his body encountered during the race and how it overcame them to enable him walk back home.

- In the mouth, the food was broken down using teeth. Starch in the food was broken down to maltose by salivary amylase in saliva secreted from the salivary gland. The food was rolled into a ball-like structure called bolus by the tongue and then swallowed. The food moves down the oesophagus by peristalsis.
- In the stomach, no chemical digestion of starch occurs.
- In the duodenum, secretion of bile juice from the gall bladder or liver and pancreatic juice from the pancreas occurs. Bile salts in the bile juice emulsify fats in to tiny droplets. Pancreatic juice secreted contains pancreatic amylase which breaks down starch to maltose.
- In the ileum, intestinal juice/succus entericus from intestinal wall is secreted containing maltase enzyme which completes the breakdown of maltose to glucose. Glucose is then absorbed into the bloodstream by the villi found in the ileum and transported to the liver and muscle cells where excess glucose is converted to glycogen for storage.
- During the race glycogen is converted to glucose that is used for respiration to produce energy. The energy was used for contraction of leg muscles to enable Nagenda run fast enough to win the race.
- During the race, oxygen supply was less than the demand, so anaerobic respiration occurred producing lactic acid that accumulated to cause muscle cramps.
- After the race, lactic acid diffused from muscles and was carried by blood to the liver where much oxygen inspired was used to oxidise this lactic acid fully to water, carbon dioxide and energy lowering its amount in muscles which allowed recovery.

88. Mr. Zinart is an athlete who loves jogging and working out everyday in the morning hours. He recently shifted from his former town X due to having been employed in a different town Y. Town Y is characterised by numerous manufacturing industries that produce numerous pollutants like toxic

fumes, smoke and dust that was minimal in town X. He used to jog everyday without any complications in town X but unfortunately when he shifted to town Y, he experienced complications such as difficulty in breathing, chest pain and coughing.

Task:
Explain to Mr. Zinart his experiences while living in town X and the new ones encountered in town Y and advise Mr. Zinart on how to manage the challenges experienced in town Y.

- In town X, the air had minimal pollutants such as dust, smoke, and toxic fumes. This allowed Mr. Zinart to jog without any respiratory complications. His lungs could easily take in sufficient oxygen, which was transported by haemoglobin in red blood cells to body tissues. The oxygen was used in aerobic respiration to produce energy (ATP), enabling effective muscle contraction and relaxation during exercise. As a result, he maintained good performance and did not experience breathing difficulties or chest pain.
- In town Y, the air is heavily polluted due to emissions from numerous manufacturing industries. The pollutants include toxic gases such as carbon monoxide, smoke, and dust. Carbon monoxide combines irreversibly with haemoglobin to form carboxyhaemoglobin, reducing the blood's oxygen-carrying capacity. This leads to less oxygen reaching muscle tissues, causing weakness, fatigue, and reduced performance.
- Additionally, inhaling dust and toxic fumes irritates the respiratory tract, triggering over-secretion of mucus by goblet cells. The excess mucus blocks air passages, making breathing difficult. The pollutants also cause inflammation and narrowing (constriction) of bronchioles, further restricting airflow and leading to chest pain. Frequent coughing occurs as a protective reflex to expel these irritants from the airways.

Advice for managing challenges in town Y

- Adjust jogging schedule to avoid peak pollution hours, typically early mornings and evenings.
- Select jogging routes away from industrial areas to reduce exposure to pollutants.
- Wear a protective mask designed to filter fine particulate matter and harmful gases.
- Consider alternative indoor exercises, such as gym workouts or yoga, to minimize outdoor exposure.
- Drink plenty of water to help keep the respiratory tract moist and support lung function.
- Schedule regular medical check-ups to monitor lung health and receive timely medical advice.
- If possible, consider relocating to an area with cleaner air to protect long-term respiratory health.

89. Jonah experienced a fatal accident where he experienced teeth loss and loss of consciousness. He was rushed to the near by hospital and on further diagnosis, it was seen that his pancreas was damaged. The doctor advised that Jonah should undergo blood transfusion immediately in addition to other medication. The hospital did not have blood but Jonah's relatives were willing to donate blood so as to save his life. They consulted the Doctor to see who would be able to donate On analysis, Jonah's cousin aged 20 years and weight of 60Kg was of blood group A, Jonahs mother aged 46 years and with a weight of 70Kg was of Blood group B, Jonahs sister aged 20 years with a weight of 38Kg years was of blood group AB and Jonah's Brother was of blood group O aged 9 years with a weight of 29Kg.
Task
a. Identify
i. the organs of Jonahs body that were affected

ii. With clear reasons, to the family who can possibly donate blood to Jonah since he was tested Being blood group AB

b. Explain how the damage of the organs affected the normal functioning of his body
Responses

a. (i) **Organs that were affected are:**

- *Mouth*
- *Brain*
- *Pancreas*

a. (ii)

- *Jonah's cousin can donate blood to Jonah. This is because; he has antigens A on the surface of his red blood cells and Jonah lacks antibodies to recognise these antigens thus there will be no agglutination. In a addition, Jonah's cousin is of legible age with an appropriate legible weight to donate blood.*
- *Jonah's Mother can donate blood to Jonah. This is because; she is of blood group B with B antigens and Jonah lacks antibodies to recognise these antigens thus there will be no agglutination. In addition, Jonah's mother is of legible age and with an appropriate weight to donate blood.*
- *Jonah's sister cannot donate blood to Jonah; this is because she has a low weight (below 45Kg) which is not recommended to donate blood.*
- *Jonah's brother cannot donate blood to Jonah because his age and weight are also not recommended by medical people to donate blood.*

b. **How organ damage affects normal body functioning**

- *Pancreas damage: Reduces insulin production, which controls blood glucose levels. Lack of insulin leads to hyperglycemia (high blood sugar levels) since glucose is not effectively taken up by cells. Damage also reduces secretion of digestive enzymes such as pancreatic lipase and pancreatic amylase, causing poor digestion of lipids and starch respectively.*
- *Teeth loss: Impairs chewing, resulting in larger food particles entering the digestive system. This reduces the surface area for enzyme action, leading to inefficient digestion and nutrient uptake.*
- *Brain damage: Loss of consciousness suggests possible head trauma affecting the central nervous system, which controls voluntary actions like movement and balance and involuntary functions such as breathing and heartbeat. Long-term effects may include memory loss, poor coordination, and reduced reflexes.*

90. Alex always plays football after classes in his rarely washed dirty shirt and his friends know him for not always drinking water but sodas. Whenever playing, he notices salty sweat and his urine deep brown always. But when his friends convinced him to drink water, he noticed seeing his urine clear and colourless and wants to understand how this happened.

Task

(a) Explain Alex's observations

Salty sweat;

- *When Alex plays football, his body temperature rises. To cool down, his sweat glands secrete sweat, which passes through the sweat duct and is released onto the skin surface through the sweat pore. This sweat contains water and dissolved salts such as sodium chloride. Since Alex does not drink enough water, his body becomes dehydrated, and the sweat becomes more concentrated, making it taste saltier.*

Brown, and later colourless urine;

- *During dehydration, the blood becomes more concentrated. This stimulates the hypothalamus in the brain to signal the pituitary gland to release more antidiuretic hormone (ADH). ADH increases reabsorption of water in the kidney tubules, especially in the collecting ducts, reducing urine volume and making it highly concentrated and deep brown in colour.*
- *When Alex starts drinking more water, blood water content increases, reducing ADH secretion. As a result, less water is reabsorbed in the kidneys, leading to the production of a large volume of dilute, clear, and colourless urine.*

(b) Explain the dangers Alex is likely to face and advise him on what he needs to do to avoid risks involved.

- *Severe dehydration: Loss of large amounts of water through sweating without adequate replacement reduces blood volume, leading to dizziness, confusion, heat exhaustion, and even heat stroke.*
- *Electrolyte imbalance: Excessive loss of salts (mainly sodium and potassium) through sweat without proper replacement disrupts nerve impulse transmission and muscle contraction, causing muscle cramps, weakness, and irregular heartbeats.*
- *Reduced kidney function: Continued production of concentrated urine increases the risk of kidney stones, urinary tract infections, and long-term kidney damage because waste products are not properly diluted and flushed out.*
- *Poor body cooling: Lack of enough body water limits sweating, impairing heat loss through evaporation and increasing the risk of overheating and heat-related illnesses.*
- *Decreased physical performance: Reduced blood volume and poor oxygen and nutrient supply to muscles lower energy levels, endurance, and overall sports performance.*
- *Increased risk of infections: Wearing a dirty, sweaty shirt without proper hygiene creates a favorable environment for bacterial and fungal infections on the skin.*

Advice to avoid risks

- *Drink enough clean water: Take sufficient water before, during, and after playing football to replace lost fluids and maintain blood volume and proper cell function.*
- *Reduce soda intake: Limit or avoid sodas since they contain high sugar and sometimes caffeine, which can worsen dehydration and do not effectively restore electrolytes.*
- *Wear clean, dry clothes: Change into clean sportswear to reduce the risk of skin infections and maintain good hygiene.*
- *Eat a balanced diet: Include fruits and vegetables to supply electrolytes such as potassium and sodium, support nerve and muscle function, and maintain overall body health.*
- *Take rest breaks: Rest in shaded or cool areas during exercise to reduce body temperature and support proper thermoregulation.*
- *Seek medical checks: Visit a healthcare professional regularly to monitor hydration levels, kidney health, and overall fitness status, especially if exercising intensively.*

91. Having been in a company of chain smokers for two years, Daniel, a teenager developed dry cough and serious chest pain and got hospitalized after coughing blood. The medical report suggested that Daniel was a smoker, which he utterly denied, and so the doctor put him on serious medication. In the course of the treatment, it was also discovered that Daniels' blood could no longer load enough oxygen, a reason why he was always very weak.

Task

Mention Daniel's Health problem and clearly explain how his body contracted it. Advise Daniel on how he can recover from the problem discovered later in the course of the treatment.

Daniel's health problem and how it arose;

- *Daniel is suffering from lung cancer, shown by his persistent dry cough, chest pain, and coughing blood.*
- *Although he denied smoking directly, he developed this condition through passive smoking, after staying for two years among chain smokers. Inhaling tobacco smoke exposes him to tar, a carcinogenic substance that accumulates in lung tissues and causes mutations in lung cell DNA, leading to uncontrolled cell division and tumor formation.*
- *Lung cancer causes narrowing and blockage of the bronchi and bronchioles due to tumor growth and fluid accumulation. This restricts airflow into the alveoli, reducing the amount of air reaching the sites of gaseous exchange. As a result, less oxygen diffuses into the blood, and the hemoglobin in red blood cells cannot load enough oxygen.*
- *Because of this reduced oxygen transport, tissues receive insufficient oxygen for aerobic respiration, leading to decreased energy production and resulting in Daniel's constant weakness.*

Advice on recovery from poor oxygen loading

- *Daniel should strictly follow his medical treatment by adhering to prescribed therapies such as chemotherapy, radiotherapy, or immunotherapy, which help destroy cancer cells and slow tumor growth.*
- *If recommended, he should consider lung surgery or a transplant since removing affected lung parts or replacing the lung can improve airflow and overall breathing capacity.*
- *He should eat a balanced diet rich in proteins to support tissue repair and include vitamins, especially vitamin C and E, to strengthen immunity and promote healing.*
- *Daniel needs to engage in moderate, supervised physical exercise such as breathing exercises and light aerobic workouts to improve lung capacity and enhance oxygen uptake.*
- *He must avoid further exposure to tobacco smoke by staying away from smokers and polluted environments to prevent additional lung damage.*
- *Finally, he should attend regular medical reviews to monitor treatment progress, evaluate lung function, and address any complications early.*

92. Galvina was always sick and initially resisted seeking medical attention because she is very stubborn but eventually realized the negative impact her deteriorating health was having on her life. When she was eventually taken to the hospital, reported symptoms of frequent urination, lower abdominal pain, Haematuria (Blood in urine), fatigue, Nausea, Vomiting, swollen feet and ankles. When her Urine was tested, it had a lot of proteins. An examination also revealed difficult in standing and alcohol in her breath.

TASK.

a. Identify the organs which were affected by the patients' symptoms.

- *Kidney*
- *Liver*

b. Identify the role these organs play in the body.

Kidney

- *Removes waste products e.g.urea from the body.*
- *Regulates water and salt balance.*
- *Controls blood pH*
- *Produces erythropoietin to stimulate red blood cell formation when oxygen is low.*

Liver

- *Detoxifies harmful substances*
- *Stores vitamins A, D, E, K, B12 and minerals*
- *Produces bile for emulsifying fats.*
- *Regulates blood glucose.*
- *Synthesizes plasma proteins.*
- *Breaks down old red blood cells.*

c. Describe the events that led to the formation of the urine that was taken to the lab for testing.

- *Much blood at high pressure supplied from the heart enters the glomerulus through the afferent vessel, which is wider than the efferent vessel. This difference in diameter creates high pressure within the glomerulus, leading to ultrafiltration. Blood then leaves the glomerulus at a lower pressure through the narrower efferent vessel.*
- *Small molecules like glucose, amino acids, urea, water pass through the minute pores into the Bowman's capsule forming glomerular filtrate. Since her Kidneys are damaged, some of the proteins and red blood cells were able to pass through these minute pores into the glomerular filtrate and were present in her urine.*
- *The glomerular filtrate flew into the proximal convoluted tubule where useful substances like glucose, amino acids, salts and water are reabsorbed back into blood. The filtrate then flows into the Loop of Henle.*
- *In the descending loop of Henle, water was reabsorbed back into blood capillaries by osmosis.*
- *In the ascending loop of Henle, salts like sodium ions were reabsorbed back into blood by active transport. The filtrate then flew into the Distal convoluted tubule where salts and water were reabsorbed further. The filtrate continued to the collecting duct.*
- *In the collecting duct, water was further reabsorbed leading to a concentrated urine that was passed to the urinary bladder through the ureter and then out of the body through the urethra.*

d. Suggest strategies for managing the condition she is suffering from.

- *Seek professional help for kidney and potential liver issues, including medications and lifestyle modifications, to control symptoms early and prevent further organ damage.*
- *Undergo a kidney transplant if medically advised, to replace severely damaged kidneys and restore normal filtration function.*

- *Start kidney dialysis if transplant is not immediately possible, to help remove waste products and excess fluids from the blood when kidneys fail.*
- *Follow a kidney-friendly diet by limiting protein, salt, sugar, and phosphorus intake, to reduce the workload on the kidneys and prevent further damage.*
- *Keep hydrated by drinking plenty of water, to help flush out toxins and support proper kidney filtration.*

93. Your School Health Team are conducting a study in which they checked on the health status of students. During the study, they measure and record the weight, age and height of the students. When asked by students why they were doing so, they replied
"We want to know your BMI Status". They also had with them a chart as seen below.

Weight classification	**BMI category (Kg/m^2)**
Underweight	<18.5
Normal weight	18.5 - 24.5
Overweight	25 - 29.9
Obesity class I	30 - 34.9
Obesity class II	35 - 39.9
Obesity class III	>40

The results of some learners in senior two include:

Name	**Age(years)**	**Height(cm)**	**Weight(g)**
Huda	14	165	64000
Zaharah	15	162	45000
Zainah	15	156	69000

Task.
a. i. Why is it important to know your BMI?

- *It gives an idea about the correct weight for height if an individual (Underweight, Normal Weight, Overweight or Obese)*
- *To know the Weight and height of an individual.*
  ii. Calculate the BMI of the above three students. Comment on their BMI Status.
- **BMI = Weight(Kg)/Height(M^2)**
  Huda: Weight = 64000/1000 = 64Kg
  Height = 165/100 = 1.65m
  BMI = $64/1.65^2$ = **$\underline{23.5Kg/m^2}$**
- Huda has normal weight
  Zaharah: Weight = 45000/1000 = 45Kg
  Height = 162/100 = 1.62m

BMI = $45/1.62^2$ = **<u>17.1 Kg/m²</u>**

- Zaharah is underweight.
  Zainah: Weight = 69000/1000 = 69Kg
  Height = 156/100 = 1.56m
  BMI = $69/1.56^2$ = **<u>28.6 Kg/m²</u>**
- Zainah is overweight

b. State three implications of being;
i) Underweight

- *Poor growth in Children*
- *Frequent sickness due to poor immune system*
- *Hormonal imbalances such as low reproductive hormones leading to irregular menstrual cycles. Increased risks of miscarriages among pregnant women*
- *Weak bones*
  Heart diseases such as heart failure, irregular heart beats.

ii) **Overweight**

- High blood pressure due to narrow blood capillaries.
- Increased risk of diabetes
- Female infertility
- Osteoarthritis (pain in the bones due to worn out cartilage)
- Swollen painful joints.
- Heart diseases

c. How can you advise a student who is;
i) Underweight

- *Take a high calorie beverage along with a meal or snack*
- *Add extras e.g. scrambled eggs and fat free dried milk in soup and stews*
- *Eat more frequently e.g. have 5 to 6 smaller meals a day rather than 2 or 3 larger meals.*
- Eat meals with fibrous carbohydrates e.g. brown rice and beans and healthy foods e.g. mono-saturated or poly saturated fats in foods e.g. nuts, avocados, oils and fish.
- Choose nutrient rich food e.g. whole grains, bread, cereals, fruits, vegetables, diary products, lean protein sources, nutsy and seeds

ii) Overweight

- Engage in weight management programs.
- Carry out regular physical exercises.
- Carry out intermittent fasting.
- Follow a healthy eating plan with fewer calories.
- Feed on calories restricted diets such as 120 to 150 calories per day for women and 1500 to 1800 calories for men.
- Take weight loss medicines as prescribed by your doctor.
- Undergo bariatric surgery for extreme obese individuals by making changes to individual's digestive systems.

94. Martha is a medium sized girl who who was employed in a certain medical facility. One day at work, Martha accidentally had a chemical substance that caused her to start emaciating, even when she ate food and she started experiencing effects that she didn't have before. When she became very thin, Martha stopped moving to work due to fear of being undermined. In the room, Martha was worried about what happened to her and always wished to recover her normal size and weight.

Task

As a biology learner, explain to Martha what happened to her body and how she can recover the normal size. Advise Martha on whether she can move back to work or not due to this situation.

Explanation of what happened to Martha;

- *Martha's sudden emaciation despite eating suggests that the chemical substance she accidentally took disrupted her body's metabolism.*
- *The most likely cause is overstimulation of her thyroid gland, leading to excess production of thyroxine, a hormone that regulates the body's metabolic rate. When too much thyroxine is produced, the metabolic rate becomes abnormally high. This causes the body to rapidly breakdown and use up stored fats and body proteins such as muscle protein for energy, leading to severe weight loss and weakness even when she eats enough food.*
- *The chemical may also have damaged her small intestine, causing poor absorption of nutrients (malabsorption), which contributes to weight loss, due to lack of nutrients for energy production, repair of worn out and damaged cells and overall body growth.*
- *In addition, if her liver was affected, its ability to metabolize carbohydrates, proteins, and fats into usable energy and vital substances for body building and growth, would be reduced. The liver normally converts glucose to glycogen for storage, synthesizes important plasma proteins like albumin, and detoxifies harmful substances. Damage to liver cells would impair these functions, reducing nutrient availability and energy production, worsening her emaciation and weakness.*

To help Martha regain her normal body size and health, she should:

- *Visit a doctor to test her thyroxine levels and assess her digestive and liver function to confirm the cause.*
- *Begin appropriate treatment, such as anti-thyroid medication to reduce thyroxine if high, and therapies for malabsorption or liver impairment as needed.*
- *Eat a balanced diet rich in proteins, carbohydrates, vitamins, and minerals to support tissue repair and weight gain.*
- *Get sufficient rest and avoid stress, which can worsen metabolic problems.*

Advice on returning to work;

- *Once treatment starts and Martha regains strength, she can confidently return to work. She should not fear being undermined, as with proper care she will recover fully and perform her duties effectively. Returning to work will also support her mental well-being and rebuild her confidence.*

95. John, a 10-year-old boy, had an accident as he was moving from school to home on a motorcycle. He had severe bleeding and lost a lot of blood which made him unconscious. Following close examination, the doctor decided that John needed an immediate blood transfusion. John is of blood

group B, and present at the hospital are John's mother of blood group A, his elder sister of blood group AB and his young brother of blood group O.

Task

(a) Workout is the possibility of each of John's relatives to successfully transfuse blood to him, and suggest remedies that could save his life.

- *John is of blood group B, implying that he has antigen B on the surface of his red blood cells and antibody a in his blood plasma.*
- *John's mother is of blood group A, she has antigen A on the surface of her red blood cells and antibody b in her blood plasma.*
- *The sister is of blood group AB, she has both antigens A and B, on her red blood cells, and lacks both antibodies a and b in her blood plasma.*
- *The younger brother is of blood group O, he lacks both antigens A and B though he has both antibodies a and b in his blood.*

According to the compatibility table below;

		Recipient			
		O	A	B	AB
Donor	O	√	√	√	√
	A	X	√	X	√
	B	X	X	√	√
	AB	X	X	X	√

- *John of blood group B, can receive blood from a donor of blood group B and that of blood group O because they don't have antigen A which would react with antibody a in John's blood to cause agglutination. Therefore, since they both lack antigen A, there will be safe transfusion.*
- *From John's relatives, it is only his younger brother with a compatible blood group O, but he is below the age recommended to donate blood.*
- *Therefore, none of his relatives available, can successfully transfuse blood to John.*

Way forward

- They should look for a mature and healthy blood donor with blood group B or blood group O, to donate blood to John immediately, as guided by the doctor (Physician).

(b) Explain the effects of loss of blood in the body.

- *Reduced oxygen transport: Blood contains red blood cells with haemoglobin that carry oxygen to tissues. Loss of blood reduces red cell numbers, causing tissue hypoxia, leading to weakness, dizziness, and possible unconsciousness.*

- *Drop in blood pressure: Loss of blood reduces blood volume, decreasing venous return and cardiac output, which leads to a drop in blood pressure (hypotension). This results in poor circulation and cold, pale skin.*
- *Decreased nutrient supply: Blood transports nutrients like glucose and amino acids to cells for energy production. Blood loss limits this supply, affecting respiration and tissue repair.*
- *Reduced removal of wastes: Blood carries carbon dioxide and other wastes to excretory organs. Reduced blood volume slows this process, causing accumulation of wastes and possible acidosis.*
- *Impaired clotting ability: Blood loss reduces platelets and clotting factors, increasing bleeding risk and impairing wound healing.*
- *Shock: Severe blood loss can cause hypovolemic shock, where organs fail due to very low blood volume and pressure, which can be fatal if not treated quickly.*

96. A 48-year old patient presents the following symptoms; swollen feet and general body weakness (fatigue). Doctors recommended the patient to have a simple meal which included bread, piece of egg and water. After three hours resting, blood and urine samples were obtained and tests on these samples made. The test results on concentration of different substances in blood and urine obtained are presented in the table below.

Substance	Concentration in blood plasma (g/dm^3)	Concentration in urine of a normal person (g/dm^3)	Concentration of the patient's urine sample (g/dm^3)
Glucose	1	0	0.9
Urea	0.3	300	50
Plasma proteins	80	0	40

Task

Explain why resting was necessary and analyse the patient's results to provide possible solutions on how the condition can be managed.

The necessity of resting:

Resting was necessary to allow glucose from the meal to be absorbed and distributed in the body without being quickly used by active muscles, ensuring accurate blood and urine test results.

Analysis of the patient's results;

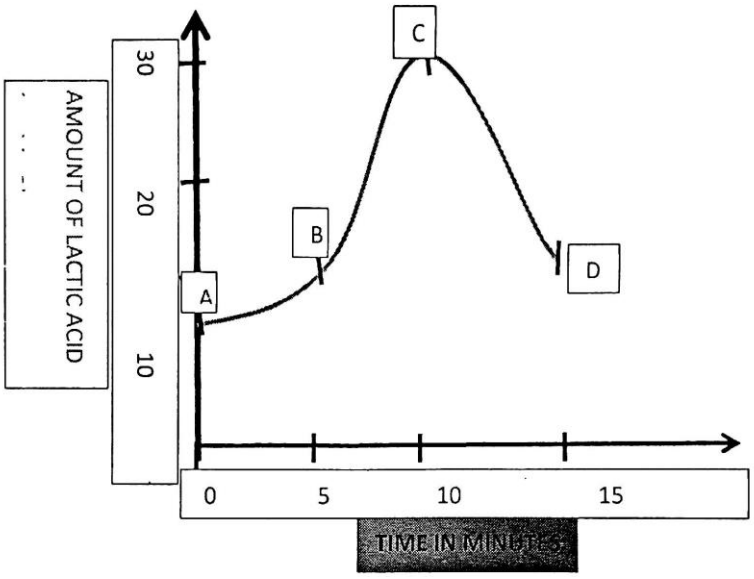
- *The presence of glucose in urine (glucosuria), indicates that the renal tubules failed to reabsorb all glucose. This suggests diabetes mellitus, where blood glucose levels rise above the kidney's reabsorption threshold.*
- *The concentration of urea in urine of the patient is low; this suggests reduced kidney filtration rate or reduced excretion efficiency, possibly indicating kidney impairment.*
- *The presence of proteins in urine (proteinuria) suggests damage to glomeruli, allowing proteins to leak into urine. This is a sign of kidney disease.*

Possible solutions to manage the patient's health condition;

- *Proper medical treatment: The patient should receive treatment for diabetes to control blood sugar e.g. insulin injections.*
- *Diet control: Reduce sugar and refined carbohydrate intake to help manage blood glucose levels.*
- *Limit salt and protein intake: To reduce kidney strain and help manage swelling (edema).*
- *Frequent monitoring: Regular blood and urine tests to monitor kidney function and blood sugar levels.*
- *Physical rest and moderate exercise: As advised by a doctor, to improve circulation and overall health without overworking the kidneys.*

97. In animals, glucose is broken down to produce energy(ATP) in body cells liberating carbon dioxide and water too, in presence of oxygen. In the absence of oxygen however, lactic acid and carbon dioxide are produced. The lactic acid produced accumulates in blood until when it is oxidized later during oxygen debt. A group of athletes were performing an exercise, they started by warming up and later vigorous splinting thereafter rested.

The graph below shows the amount of lactic acid produced during the time of exercise.



Tasks

(a) What do points on the graph represent?

(i) A-B

- ***Warming up.***

(ii) B-C

- ***Vigorous exercise.***

(iii) C-D

- ***Recovery period***

(b) Which points on the graph represent.

(i) Start of exercise

- ***Point A***

(ii) End of exercise/muscle fatigue

- ***Point C***

(iii) Recovery period

- ***Between C-D***

(iv) Oxygen debt

- ***Between C-D***

(c) Why is the amount of lactic acid;

(i) increasing slowly between A-B

- ***This is because the athletes are doing mild exercise (warming up), muscles are still using mostly aerobic respiration with only a small contribution from anaerobic respiration.***

(ii) increasing rapidly between B-C

- ***During the vigorous exercise, the need for oxygen is higher than the oxygen being supplied. The active muscle cells respire anaerobically to increase energy production, leading to rapid production of lactic acid as the vigorous exercise proceeds.***

(iii) decreasing rapidly between C-D

- ***Through rapid and deep breathing, the athletes take in extra oxygen, used to oxidize lactic acid in the liver into carbon dioxide, water, and energy; causing lactic acid levels to decrease rapidly.***

98. During interclass competitions, two students Rashford and Bukayo were selected for the event. Bukayo spent a month before, training regularly and feeding on sweet potatoes and milk, as well as drinking a lot of water. Rashford used not to train and used to eat a lot of junk foods from the school canteen, he however concentrated on morning drills everyday before the competition. During the event, Rashford started well but could not complete the race for he became very weak, developed muscle cramps and abnormal heartbeat, while Bukayo won the race.

<u>Task</u>

(a) Explain how Bukayo's earlier preparations contributed to his success.

- *Regular training strengthened Bukayo's heart muscle and increased lung capacity, improving cardiac output and oxygen uptake. This ensured more oxygen was delivered to muscle cells, supporting increased aerobic respiration during the race.*
- *Muscle cells adapted to training by increasing the number and size of mitochondria, enhancing aerobic ATP production capacity, which reduced reliance on anaerobic respiration and limited lactic acid buildup that causes muscle fatigue.*
- *Sweet potatoes provided starch, digested into glucose in the gut. Glucose entered the bloodstream, and excess glucose was converted into glycogen in the liver and muscle cells. During the race, muscle glycogen was broken down to glucose to fuel aerobic respiration and maintain energy supply.*
- *Milk supplied essential amino acids for muscle protein synthesis, aiding repair and growth of muscle fibers, and calcium ions necessary for muscle contraction and maintaining bone density, reducing injury risk.*
- *Adequate water intake maintained blood volume and electrolyte balance (sodium, potassium), supporting nerve impulse transmission and enzyme activity, thus preventing muscle cramps and maintaining performance.*

(b) Basing on the earlier events, explain why Rashford didn't complete the race and advise him accordingly.

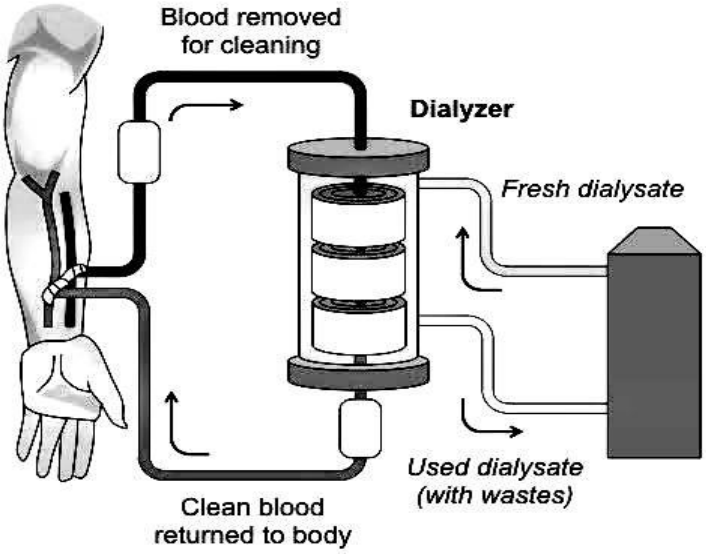
<u>Why Rashford did not complete the race</u>

- *Lack of consistent training resulted in poor cardiovascular fitness, limiting oxygen delivery and reducing ATP production by aerobic respiration, causing early onset of muscle fatigue.*
- *Due to low oxygen supply, Rashford's muscles relied heavily on anaerobic respiration during the race, causing rapid lactic acid accumulation. This buildup led to muscle cramps, fatigue, and impaired muscle contraction, forcing him to stop.*
- *Frequent consumption of junk foods limited complex carbohydrate intake, resulting in low glycogen stores in liver and muscles; this restricted available glucose for energy during exercise.*
- *Short morning drills without sustained training failed to induce mitochondrial biogenesis or cardiovascular adaptations, reducing endurance capacity.*
- *Poor hydration and electrolyte imbalance disrupted nerve and muscle cell membrane potentials, causing muscle cramps and arrhythmia, which impaired muscle function and led to race termination.*

<u>Advice to Rashford</u>

- *Rashford should engage in regular aerobic and strength training to improve cardiovascular efficiency, increase mitochondrial density in muscles, and enhance oxygen utilization, which will reduce lactic acid buildup during exercise.*
- *A diet rich in complex carbohydrates such as sweet potatoes and whole grains should be adopted to increase glycogen storage, alongside proteins to support muscle repair.*
- *Maintaining hydration and electrolyte balance before, during, and after exercise is vital for nerve conduction, muscle contraction, and efficient removal of lactic acid.*
- *He should minimize junk food consumption to avoid poor energy availability and nutrient deficiencies that impair physical performance.*

99. Kidneys filter blood, separate useful materials from excretory wastes and control water content. However, in some cases, the kidneys may fail to carry out these important roles. One of the treatments of kidney failure is connecting a patient to a dialysis machine.



Task

(a) Describe the mechanism of operation of the dialysis machine.

- *Blood is withdrawn from a vein strengthened by an arteriovenous (AV) fistula, which is a surgical connection between an artery and a vein in the arm that allows higher blood flow.*
- *A pump in the dialysis machine draws the blood and passes it through a filter called a dialyzer, which contains a semipermeable membrane.*
- *On the other side of the membrane is a special fluid called dialysate, which has no urea or excess salts but has normal concentrations of important substances.*
- *Wastes like urea, excess salts, and extra water move from the blood across the membrane into the dialysate by diffusion and osmosis.*
- *Large useful substances like blood cells and plasma proteins remain in the blood because they cannot pass through the membrane.*
- *Finally, the cleaned blood is returned to the patient's body through another vein.*

(b) How is the dialysis machine suited to perform this role?

- *It has a semipermeable membrane for selectively removing small waste molecules like urea while retaining blood cells and proteins.*
- *It has controlled dialysate composition for creating proper concentration gradients to remove wastes without losing essential substances.*
- *It has an AV fistula connection for providing strong blood flow to allow efficient cleaning of large blood volumes.*
- *It has adjustable dialysate osmolarity for removing excess water to control blood volume and prevent swelling.*

- *It has automatic monitoring systems for maintaining correct flow rates and pressures to ensure safe and continuous blood purification.*

(c) Explain how the operation of the dialysis machine is different from that of the human kidneys.

- *The dialysis machine depends only on passive processes (diffusion and osmosis) for waste removal, while kidneys also use active transport to reabsorb and secrete substances precisely.*
- *Kidneys have millions of nephrons for fine adjustment of water, salts, glucose, and pH, but the dialysis machine cannot perform this detailed regulation.*
- *Kidneys produce hormones, erythropoietin and renin for blood cell production and blood pressure control respectively; the dialysis machine lacks this function.*
- *Kidneys work continuously, maintaining constant internal balance, whereas dialysis is intermittent and cannot provide steady regulation.*
- *Kidneys perform selective reabsorption to conserve useful substances, while the dialysis machine only removes substances by concentration gradients without selective reabsorption.*

100. David's 3-year-old son was attacked by sickness that resulted in the breathing difficulties, high body temperature, vomiting and soars in the mouth. The baby was rushed to the hospital and after some treatment, the breathing normalized and the vomiting ceased. The doctors advised that although the baby was still anaemic, the most appropriate treatment is proper diet that can enable the baby fully recover.

Task

(a) Explain how the sickness affected the normal functioning of the baby's body.

- *Breathing Difficulties; This reduced the amount of oxygen reaching the body's cells, leading to fatigue and poor organ function.*
- *High Body Temperature (Fever); It increases the metabolic rate, causing dehydration and weakness, especially in a child.*
- *Vomiting; Led to loss of fluids and nutrients, which can result in dehydration*
- *Mouth Sores; Made it painful to eat, reducing food intake and worsening malnutrition.*
- *Anaemia; Means the baby had low red blood cell levels or low hemoglobin. This reduced the oxygen-carrying capacity of the blood, causing tiredness, weakness, and slowed recovery.*

(b) Suggest an appropriate diet with reasons which will enable the baby to recover as per the doctor's advice.

- *Eating Iron-rich foods to treat anemia e.g. mashed beans, lentils, liver, minced meat, and green leafy vegetables (like spinach). Iron is essential for producing red blood cells and increasing hemoglobin levels.*
- *Eating protein-rich foods in order to enable cell repair and growth such as eggs, milk, yogurt, soft fish, chicken, and groundnuts (peanut paste) Proteins help in body tissue repair.*
- *Eating vitamin C-rich foods to boost the immune system and fight infection such as oranges, mangoes, tomatoes, pawpaw, and guavas.*
- *Eating energy-giving foods to replace lost energy such as porridge, rice, potatoes, bananas, maize meal, and bread. These foods provide energy needed for recovery and daily activity.*
- *Drinking more boiled and clean water, soups, oral rehydration solution (ORS), and fresh juice in order to replace lost fluids due to fever and vomiting, and prevent dehydration.*

101. Okello, a 16-year old student is recovering from a kidney disorder and is blood group B. His nephrologist recommended him to have a diet rich in brown rice, grilled chicken, avocado, steamed vegetables, water and electrolytes, which the school nurse strictly observes. However, on his latest hospital visit, the doctor diagnosed Okello anaemic and carried out a successful blood transfusion.

Task

(a) Explain how Okello's diet was utilized by the body to enable him recover quickly and continue with his studies.

The food was then digested, absorbed, and assimilated as follows:

Brown rice (starch):

Salivary amylase in the mouth hydrolyzed starch into maltose. Pancreatic amylase in the duodenum continued breaking down the remaining starch into maltose. Maltase in the ileum hydrolyzed maltose into glucose. The glucose was absorbed through villi into capillaries of the ileum, transported by the hepatic portal vein to the liver, where excess glucose was converted to glycogen for storage and the rest released into the blood to maintain normal glucose levels, then transported in blood to cells. In cells, glucose was oxidized in respiration to release energy needed for tissue repair, active transport, and brain functions for learning.

Grilled chicken (proteins):

Pepsin in the stomach broke proteins into polypeptides. Trypsin in the duodenum further digested proteins and polypeptide into smaller peptides. Peptidases in the ileum hydrolyzed peptides to amino acids. The amino acids were absorbed through villi into capillaries of the ileum, transported via the hepatic portal vein to the liver for modification. In the liver, excess amino acids were deaminated, while the rest were released into blood and transported to body cells. In cells, amino acids were used to build new tissues, produce enzymes and hormones, and form antibodies for defense.

Avocado (lipids):

In the duodenum, bile salts emulsified lipids to increase surface area. Pancreatic lipase, secreted into the duodenum, digested lipids into fatty acids and glycerol. Intestinal lipase, in the ileum, completed the breakdown of remaining lipids. The fatty acids and glycerol were absorbed into lacteals in the ileum, transported via lymph vessels into the bloodstream, and delivered to body cells. In cells, they were used to build cell membranes, synthesize some hormones, and act as an energy reserve.

***Vitamins and minerals**, were absorbed mainly in the ileum, transported in the blood to cells where they:*

Acted as coenzymes or cofactors to enable enzymes to release energy and repair tissues e.g. B vitamins as coenzymes in glucose breakdown for energy; zinc in protein synthesis and wound healing.

Supported bone development and oxygen transport e.g. calcium strengthened bones; iron formed hemoglobin for oxygen transport; vitamin C promoted collagen formation and boosted immunity.

Water and electrolytes, absorbed mainly in the large intestine, maintained fluid balance and cell hydration, regulated nerve impulses and muscle contraction e.g. sodium and potassium, and kept body pH stable for proper enzyme activity.

(b) Identify and explain the measures used by the nephrologist to ensure that Okello continues with his studies.

- *Recommended a balanced, kidney-friendly diet, to promote healing and prevent further kidney damage, keeping him strong enough for school activities.*
- *Regular monitoring and follow-up visits, to assess recovery progress and ensure stable health for uninterrupted studies.*
- *Correcting anaemia by blood transfusion, to restore red blood cell count, improve oxygen transport, and enhance energy and concentration needed for learning.*
- *Advice on adequate hydration and electrolyte intake, to support kidney function and prevent further complications that could affect school attendance.*

(c) Suggest the possible blood donor to Okello and risks involved during the blood transfusion.

- *Okello has blood group B, so he can receive blood from donors of blood group B and O.*
- *This is because blood group B donors have antigen B on their red blood cells, the same as Okello, and his plasma contains antibody a, which does not attack antigen B. Therefore, no agglutination occurs. Blood group O has no A or B antigens on its red cells, so it does not trigger any agglutination in the recipient.*

Risks involved;

- *Hemolytic reactions: Occur if there is ABO or Rh incompatibility leading to agglutination and destruction of donor red cells by recipient antibodies.*
- *Transmission of infections: Risk of diseases such as HIV and hepatitis if blood is not properly screened.*
- *Allergic reactions: Result from immune responses to donor plasma proteins.*
- *Iron overload: Excess iron accumulation in organs after multiple transfusions, possibly damaging liver and heart.*

102. Dorotia, a 70 year old grandmother, was brought to hospital with complaints of weak bones, tooth loss, slow healing of wounds, and frequent forgetfulness. Doctors related her condition to lack of essential vitamins and minerals. Her family wants to help her using diet but they need proper guidance.

Task:

Identify the causes of Dorotia's health condition.

Suggest a well balanced diet to help improve her condition and advise on other non dietary practices that would support her recovery.

Causes of Dorotia's condition:

- ***Calcium and vitamin D deficiency***: Weakens bones and causes osteoporosis because calcium forms the mineral part of bones, and vitamin D enables the absorption of calcium in the intestines.
- ***Vitamin C deficiency*** : Slows wound healing and damages gums because vitamin C is needed for collagen synthesis, which supports skin and connective tissues.
- ***Vitamin B12 and folate deficiency:*** Leads to memory loss because both are required for myelin formation and neurotransmitter synthesis, essential for nerve function.

- ***Poor intake of other minerals*** such as **phosphorus**, **magnesium**, **zinc**; Affects bone strength and tissue repair because these minerals support bone formation and act as cofactors in key metabolic reactions.

Suggested well-balanced diet:

- ***Dairy products*** *such as* ***milk, cheese, yogurt****; that provide calcium for strong bones and teeth.*
- ***Fatty fish and egg yolks:*** *Supply vitamin D to enable calcium absorption and strengthen bones.*
- ***Fruits and vegetables,*** *such as* ***oranges, guava, bell peppers, spinach****; that provide vitamin C for collagen synthesis, aiding wound healing and gum health.*
- ***Whole grains, legumes, nuts, and seeds;*** *Supply B vitamins, magnesium, zinc, and protein to support bone strength, tissue repair, and metabolism.*
- ***Lean meat and liver*** *; Provide* ***vitamin B12, iron,*** *and* ***protein*** *to support nerve function, tissue repair, and cognitive health.*

Other non-dietary practices to support recovery:

- *Regular safe sunlight exposure: Stimulates vitamin D production for calcium absorption and bone health.*
- *Weight-bearing exercises: Strengthen bones and maintain mobility.*
- *Proper dental hygiene: Prevents further tooth loss and gum disease.*
- *Mental stimulation and adequate sleep: Support memory and cognitive function.*
- *Avoid smoking and excessive alcohol: Protect bones and overall health from further damage.*

103. Joshua a good athlete decided to compete in a 10000m race when he was fasting. During the race, he felt weak and had muscle pain. He also observed several changes on his body including an increase in breathing rate, heartbeat and sweating. However, he had some energy to complete the race. After the race, he breathed deeply and rapidly and later the pain disappeared.

Task

a) Explain the challenges that Joshua faced during the race.

- *Muscle pain: Vigorous running increased energy demand in muscles. Oxygen supply was insufficient for aerobic respiration, forcing muscles to rely on anaerobic respiration, producing lactic acid that accumulated and caused pain.*
- *Weakness and fatigue: Fasting had depleted glycogen stores in the liver and muscles, so less glucose was available for respiration, reducing ATP production and causing fatigue.*
- *Rapid heartbeat and increased breathing rate: To meet the high oxygen demand of muscles during running, his heart and lungs worked faster, reflecting physical strain.*
- *Excessive sweating: High metabolic rate generated heat; sweating occurred to cool the body, leading to water and salt loss that could worsen fatigue.*

b) How was Joshua's body able to overcome the challenges experienced?

- *Removal of lactic acid: Lactic acid diffused into the blood and was transported to the liver, where it was oxidized into carbon dioxide, water, and energy once extra oxygen was supplied through deep post-race breathing.*
- *Energy from fats: After glycogen was depleted, stored fats were broken down and oxidized to provide energy that allowed him to finish the race.*

- *Supportive body responses: Rapid breathing and heartbeat during the race supplied oxygen to muscles, and sweating helped regulate body temperature, preventing overheating and aiding continued muscle function.*

104. Ritah decided to skip meals and takes dietary pills in an attempt to improve her body image. She usually depends on sweets but rarely brushes her teeth. She also usually stays in a company of other girls who smoke. Recently, she has become bony and started falling sick more often. She also started complaining of breathing difficulties , toothache, and was diagnosed with high blood pressure. All her conditions were attributed to her lifestyle.

Task

(a) Explain how Ritah's lifestyle caused the challenges she is experiencing recently.

- *Weight loss: Skipping meals and relying on dietary pills deprived her body of energy and essential nutrients, leading to loss of fat and muscle mass, hence appearing bony.*
- *Frequent illness: Lack of proteins, vitamin C, and iron weakened her immune system, reducing antibody production and lowering resistance to infections.*
- *Difficulty in breathing: Inhaling second-hand smoke irritated and inflamed her airways, damaging the cilia and causing excess mucus production. This narrowed the air passages, reduced oxygen absorption in the alveoli, and led to difficulty in breathing.*
- *Toothache: Frequent consumption of sweets without brushing promoted bacterial growth on teeth, producing acids that eroded enamel and caused decay.*
- *High blood pressure: Poor diet high in sugar and low in nutrients, combined with stress, causes blood vessel constriction and changes in fluid balance, leading to increased blood pressure.*

b) What advice can you give to her to live a better life life?

- *Eat regular, balanced meals rich in carbohydrates, proteins, fats, vitamins, and minerals to maintain energy, immunity, and healthy body weight.*
- *Limit sugary foods and brush teeth at least twice daily to prevent tooth decay.*
- *Avoid exposure to cigarette smoke to protect the lungs and overall respiratory health.*
- *Engage in regular physical activity to strengthen the heart, muscles, and lungs.*
- *Maintain a healthy body image and avoid harmful weight-loss practices like skipping meals or excessive dietary pills.*

SELF-TEST ITEMS

105. A 60-year old woman has a neck lump (swelling), frequent back pain, and poor vision. Doctors further revealed that she has porous bones in her vertebral column and age related long sightedness. Her family members may manage her condition through diet. The family people lack correct plan and nature of diet to administer.

Task

Explain the cause for the old woman's health condition, suggest how a suitable diet and sight defect correction would manage her condition.

106. Musa has a very anaemic child admitted in Mulago hospital, the doctors have advised that blood transfusion should be done within the next three days to save this child. The child's blood group has been established as A. The hospital has run short of blood in the blood bank, so the advice was to get

blood from any of the family members. Musa has four mature children who are all ready to donate blood to save their young sibling. Umar has blood group O, Ddembe has blood group B, Zainah is of blood group A and is HIV positive, while Shanitah is of blood group AB.

Task

You're Musa's friend and he has told you about all this, make a write up with clear illustrations to help Musa transport the rightful child to donate blood so that he can save money for transport and the life of the sick child. Give reasons for the choice of the child and ignoring others.

107. Days before interhouse football competitions are held, participants are always encouraged to eat a balanced diet and to do regular exercises. For this year's interhouse competitions, one learner who had been awarded as the best player refused to feed on the recommended balanced diet and to do regular exercises claiming that he was fit enough for the competition. During the first football match of the competition, he collapsed towards the end of the first half. This player had a sudden and painful muscle pull and was breathing in and out heavily. Many members of his house were disappointed and couldn't understand why their best player had collapsed.

Task

Write a presentation you would deliver to members of the house explaining the cause of the problem.

108. Mr. Hassan took a cup of porridge before going for his routine exercises in the gym. He started exercising with vigor but later felt muscle pain and fatigue. He decided to sit down but continued to experience rapid breathing and feeling hot which later stopped and the pain also disappeared. He took a glass of juice, and went back home.

Task

(a) (i) Describe how the porridge enabled Mr. Hassan carry out his exercises in the gym.
(ii) Explain the challenges his body experienced during the exercise.

UCE BIOLOGY PRACTICAL

First practical element of construct

- ***The learner Appreciates Science inquiry skills.***

This is assessed in the end of cycle biology practical paper as ***item 1.***

The learner is required to design, perform an investigation, write a report and make conclusions basing on what he/she has performed.

The following areas of study are assessed on number 1;

Food tests, Soil experiments, Osmosis, and Enzyme activities.

Success criteria

The learner should revise the physiology under the areas of study listed above and practice several experiments under each of them repeatedly to aquire science inquiry and experimentation skills.

Some example items and responses have been given below;

TYPICAL EXAMINATION BIOLOGY PRACTICAL ITEMS WITH RESPONSES.

Item 1

After weaning her baby, Akumu introduced her to a new diet. Six months later the baby developed a pot belly, bleeding gums, started falling sick frequently. The neighbors suggested that Akumu should add some other foods to the baby's diet to improve the baby's condition. Food samples in solutions P, Q, R and S are some common in Akumu's environment.

Task

Carryout a scientific investigation on all the food samples and then use your results to advise Akumu on which ones to be added to the baby's diet. (your investigation should include aim, hypothesis, variables, materials, results of experiment, analysis and recommendation).

Responses

Aim: A scientific investigation to find out the nutrient composition of solution P, Q, R, S so as to know which ones to be added to the baby's diet for good health.

Hypothesis: Solutions P, Q, R and S contain proteins and vitamin C

Variables;

Independent variable: Solutions P, Q,R, S and Reagents used

Dependent variable: colour changes.

Controlled variable: volume of solutions P, Q, R, S. volume of reagents used.

Materials

Test tubes, dropper, testtube rack, dilute sodium hydroxide solution, copper (II) sulphate solution, DCPIP solution.

Procedures;

Protein test

To $1cm^3$ of solution P,Q,R and S in separate test tubes was added $1cm^3$ of dilute sodium hydroxide solution followed by 3 drops of Copper (II) sulphate solution and the solution shaken.

Vitamin C test

To $1cm^3$ of DCPIP solution in a test tube, was added food solution P, Q, R and S separately drop by drop till in excess.

Observations and deductions

Test	Solution	Observation	Deduction
	P	A turbid solution turned to a blue solution which persisted.	Proteins absent.

Proteins test	Q	A turbid solution turned to a blue solution which persisted.	Proteins absent.
	R	A turbid solution turned to a blue solution then to a **purple solution.**	**Proteins present.**
	S	A colourless solution turned to a blue solution which persisted.	Proteins absent.
Vitamin C test	P	The deep blue solution of DCPIP remained blue.	Vitamin C absent.
	Q	The deep blue solution of DCPIP turned to a **colourless solution.**	**Vitamin C present.**
	R	The deep blue solution of DCPIP remained blue.	Vitamin C absent.
	S	The deep blue solution of DCPIP remained blue.	Vitamin C absent.

Analysis and recommendation

Solution R contains proteins while solution Q contains vitamin C. The proteins build the body tissues reducing the effect of pot belly in children. The vitamin C boosts immunity of the baby reducing frequent sickness and bleeding gums in the baby.

Item 2.

Nakabito a chips seller in Wandegeya market noticed that most people enjoy eating Irish potatoes in sliced fried form. She cuts them into small pieces and allows them to settle in water for some time in preparation for frying them. Nakabito's customers enjoy the chips and even pack some for their children home. In a rush to serve her customers, she bought 2 jerry cans of water to use the next day and soaked the sliced Irish potatoes in them. The next morning the sliced pieces were fried and served to the customers but noticed that they were different from the normal ones always served since they were small in size. Nakabito is afraid of making losses.

Solutions Q and R are samples from the two jerry cans and plant organ M is similar to what Nakabito uses in her business.

Task

Carry out a scientific investigation on solution Q and R with plant organ M so as to help Nakabito save her business.

Responses

Aim; A scientific investigation to determine the effect of solution Q and R on plant organ M so as to explain the difference in the quality of chips made by Nakabito in order to save her business.

Hypothesis: Concentration of solutions Q and R have different effects on specimen M.

Variables:

Independent: Concentration of the solution Q and R

Dependent; Texture and final length of the cylinders.

Controlled; Initial length of cylinders, initial volume of solutions Q and R, time taken for cylinders to settle in solution.

Materials

Cork borer, test tubes, knife, labels, stop clock, measuring cylinder, Specimen M, solutions Q and R.

Procedure

- Using a cork borer, two cylinders were obtained from specimen M.
- The cylinders were then trimmed to a uniform length of 3cm long.
- Two test tubes were then labelled as Q and R.
- 10 cm^3 of each solution poured into each testtube then one cylinder was dropped into the solutions.
- The set up left to stand for 20 minutes.
- After this time, the cylinders were then removed and placed on a white paper then their final length measured and the cylinders felt between fingers. The results were then recorded in the table below.

  Results

Solution	Initial length (cm)	Final length (cm)	Change in length (cm)	Texture of the cylinder
Q	3.0	3.1	+0.1	Hard, rough.
R	3.0	2.9	-0.1	Soft, smooth.

Recommendation and analysis

- From the results above the cylinder that was placed in solution Q increased in length, became hard and rough because it was placed in a hypotonic solution to the cell sap hence water moved by osmosis from the solution to the cylinder causing it to swell and become turgid making the chips appear bigger in size for sell.
- When the chips were soaked in solution R they decreased in length, became smooth and soft because the cylinder was placed in a hypertonic solution to the cell sap hence lost water by osmosis to solution R making the cells to shrink and become flaccid. This explains why the chips appear small in size. Hence I recommend that Nakabito should always use water from source Q to soak her sliced Irish potatoes.

Item 3

Rice grows well in swampy areas. A farmer bought two different plots of land in the same area to grow rice on large scale. plot A is on a slightly raised area while plot B is located at the valley. He planted the same quantity of rice seedlings on both areas A and B. The farmer observed that the roots of many rice plants from plot A had short roots and a few had long roots while those of plot B all had many short roots. At harvest time the yield from plot B was more than from plot A. The farmer was told that the difference in yield was due to difference in the soils' ability to retain water. The famer wants to know why the two plots have different yields.

Task

You are provided with soil samples A and B obtained from the two plots. Design and Carryout a scientific investigation on soil samples A and B to determine which plot of land would give the farmer better yields. Use your results to explain the difference in yields of the farmer.

Responses

Aim: A scientific investigation to determine the ability of the soil samples A and B to retain water so as to explain to the farmer which one of the plots would give the him better yields.

Hypothesis

Soil sample B retains more water than soil sample A.

Variables

Independent; soil samples A and B, nature/ size of soil particles.
Dependent; volume of water retained and collected, time taken for the first drop to appear.
Controlled; volume of soil used, volume of water added, time taken for the experiment,
size of funnel, amount of cotton wool.

Procedure

- Two beakers were labeled as A and B.
- A small piece of cotton wool was obtained and placed on the neck of the funnel on each of the two measuring cylinders.
- 30 cm^3 of each soil sample was measured differently and poured onto each funnel.
- 30cm^3 of water was added to each of the soil samples.
- The experiment was then left to stand for 20 minutes.
- After this time, the volume of water collected and retained was then recorded in the table below;

Results

Soil sample	A	B
Volume of water added (cm^3)	30.0	30.0
Volume of water collected (cm^3)	12.0	7.0
Volume of water retained (cm^3)	18.0	23.0

Analysis and recommendation

From the results above, soil sample A retains less water hence many plants with short roots absorbed less water needed for photosynthesis as most of it is washed away to the bottom or valley with the nutrients leading to reduced yield. Soil sample B retains more water hence plants with many short roots can easily absorb it for photosynthesis as the many few roots increase the surface area for water absorption hence increased yield. I therefore recommend the farmer to use plot B to grow rice for better yield.

Item 4

Hamza is a better swimmer than Fred. In preparation for a swimming competition that would take place in three months time, Fred visited a nutritionist to find out a suitable diet to feed on, and Hamza continued on his usual diet. Both of them continued with their normal training. During the competition, Fred emerged the winner. Hamza was disappointed and wondered why he didn't win.

Solution R is a sample from the nutritionist's recommended diet for Fred.

Solution S is a sample of the usual diet of Hamza.

Task.

Design and carryout investigations on solution R and S. Use your results to explain to Hamza why he didn't win.

Responses:

(a) Aim of the experiment
An experiment to determine the nutrient compositions of food solutions R and S so as to explain to Hamza why he did not win the competition.
Hypothesis
Food sample S lacks proteins and vitamin C which are present in sample R.
Variables in the experiment
Independent variables: Food sample R and S, Test reagents.
Dependent variables: Colour changes
Controlled variables: Volume of food solution, volume of reagents.

Materials

Source of heat, Test tubes, dropper, test tube rack, iodine solution, Benedict's solution, dilute sodium hydroxide solution, copper (II) sulphate solution, DCPIP solution, Test solutions R and S.
Procedure and results

Test	**Test solution**	**Observation**	**Deduction**
To 1 cm^3 of the test solution in a test tube, was added 3 drops of iodine solution.	R	A turbid solution turned to a black solution.	Much starch present.
	S	A turbid solution turned to a blue solution.	Moderate starch present.
To 1 cm^3 of the test solution in a test tube, was added 1 cm^3 of Benedict's solution and then boiled.	R	A turbid solution turned to a blue solution, to a green solution and finally to a yellow precipitate.	Moderate reducing sugars present.
	S	A turbid solution turned to a blue solution and finally to a green solution.	Little reducing sugars present.
To 1 cm^3 of the test solution in a test tube, was added 1 cm^3 of sodium hydroxide solution followed by 3 drops of copper (II) sulphate solution, and then shaken.	R	A turbid solution turned to a blue solution, and then to a **purple solution**.	Proteins present.
	S	A turbid solution turned to a blue solution which persisted.	Proteins absent.

To 1 cm^3 of DCPIP in a test tube, was added the test solution drop wise until in excess.	R	The deep blue solution of DCPIP turned to a **colourless solution**.	Vitamin C present.
	S	The deep blue solution of DCPIP remained blue.	Vitamin C absent.

Analysis of results

- Fred's diet contained more carbohydrates than that of Hamza. Upon compte digestion, the carbohydrates such as starch yield glucose. Which was absorbed into the villi of the ileum to blood capillaries and transported to the liver through the hepatic portal vein. Excess glucose was converted to glycogen for storage in the liver and muscle cells. During the swimming exercise, glycogen was converted to glucose that was oxidized to produce energy for muscle contraction during swimming. More glycogen was stored in Fred's muscles hence more energy reserves in his muscles than in Hamza's muscles.
- Fred's diet contained proteins and vitamin C which are lacking in Hamza's diet. Proteins helped to build muscles in Fred's body during training and vitamin C provided a strong immunity ensuring that he did not fall sick during the three months training. Hamza on the other hand lacked proteins therefore his muscles were not well built and could have fallen ill during the training period due to weak immunity. Hamza could not win Fred in the competition.

Item 5

A juice manufacturing company makes their juice clear with substance K which is an enzyme. Normally, when the juice is mixed with the substance, bubbles are seen coming out of the mixture. There is a strict instruction that only pure water should be used to mix the substance or else it will not work. One day, a worker was rushing and mixed the substance with a wrong liquid, there were two liquids R and Q in two jerrycans. That day, the juice made was not clear and customers complained. The manager wants to identify the solution that the worker used, and to explain to him how the wrong solution affects the performance of the substance.

You're provided with;

Solution M, which is a sample of the juice from the company.

Solution K, which is a sample of the substance used to clear the juice.

Solutions R and Q, which were present at the company, one of which was the wrong solution used by the worker.

Task

Carryout investigations on the samples provided to find out which one of the solutions the worker used resulting into poor quality juice.

Your design and investigation should include the following;

(a) Aim, hypothesis, variables, and apparatus/requirements.

(b) Procedure for investigation

(c) (i) Identify which solution could have caused the problem.

(ii) Explain to the worker how the solution affects the working of substance K on the juice.

Responses

a) Aim, hypothesis, variables, and apparatus/requirements

Aim

A scientific investigation to determine the effect of solutions R and Q on substance K so as to explain why the juice made was not clear and help the company identify the solution wrongly used.

Hypothesis

Solutions R and Q have different effects on the activity of substance K.

Variables

Independent variable: Type of solution mixed with substance K (R or Q).

Dependent variable: Bubble formation and clarity of the juice.

Controlled variables: Volume of substance K, volume of juice, volume of solutions R and Q, temperature, and time of reaction.

Apparatus/requirements

Test tubes, measuring cylinders, droppers, stirring rods, labels, stop clock, solution K (enzyme), solutions R and Q, fresh juice sample, solution M (unclear juice sample from the company).

(b) **Procedure**

- Three test tubes were labeled as K + Water, K + R, and K + Q.
- 5 cm^3 of substance K was measured and poured into each of the three test tubes.
- 5 cm^3 of pure water was added to the first test tube labeled K + Water.
- 5 cm^3 of solution R was added to the second test tube labeled K + R.
- 5 cm^3 of solution Q was added to the third test tube labeled K + Q.
- The mixtures were stirred thoroughly.
- 5 cm^3 of fresh juice sample was added to each of the three test tubes.
- The contents were gently stirred and left to stand for 10 minutes.
- After this time, observations were made on bubble formation and the clarity of the juice in each test tube.
- The results were then compared with solution M (the unclear juice sample from the company).

Results and interpretation

Solution used	**Bubble formation**	**Clarity of the juice**	**Comparison to solution M**
K + water	Bubbles formed	Clear juice	Different from M

K + R	No bubbles formed	Unclear juice	Similar to M
K + Q	Bubbles formed	Clear juice	Different from M

(c) (i) Identifying the solution that could have caused the problem

From the results above, solution R did not produce bubbles and the juice remained unclear. This matched solution M (the juice sample that was unclear and complained about). Therefore, solution R was the solution wrongly used by the worker.

(ii) Explanation to the worker

Substance K is an enzyme that clears juice by breaking down suspended particles, releasing bubbles as a sign of its activity. Enzymes are very sensitive and work best at their specific optimum pH, which depends on the type of enzyme. In this case, substance K works best when mixed with pure water, that provides a neutral pH, that allows it to maintain its correct three-dimensional structure and shape of active site.

When solution R was used, it likely had an acidic or alkaline pH, which denatured the enzyme by changing the its 3-dimensional structure and shape of the active site. As a result, the enzyme could no longer function, no bubbles were formed, and the juice remained unclear, leading to customer complaints.

Recommendation

I recommend that the company should always use pure water or solution Q, which did not interfere with the enzyme when mixing substance K to ensure the juice is always clear and customer satisfaction is maintained.

PRACTICE ITEMS

Item 6

Sanyu, a 17- year old teenager and a long-distance runner is part of the team heading to represent their school in inter-school competitions at the district. In the past three days, Sanyu has complained of body weakness and is scared if she will be able to bring the trophy to the school. Her coach has advised her to supplement her diet with specimen A, for the remaining days ahead to the competitions. You have been provided with specimen A.

Task

Carry out a scientific investigation on Specimen A to establish its nutrient composition. Explain to Sanyu why the couch's recommendation might yield positive results.

Your design and investigation must include the following:

(a) Aim , hypothesis, variables, apparatus/requirements.

(b) (i) Procedure to investigate nutrient composition of specimen A.

(c) Use your findings to explain to Sanyu why the coach's recommendations might yield positive results.

Item 7

Musa is a young farmer; he has two separate pieces of land (A and B), that he cultivates. He plans on using one piece for growing rice next season. He has heard over the radio that rice grows best in soils with enough water and slightly acidic conditions. Musa is wondering which land could give him the best yield.
Samples of soil from the two pieces of land have collected. Samples A and B are from the respective pieces of land.
Task:

Design and carryout a scientific investigation(s) on the two samples and use the results to advise Musa.

Second practical element of construct

- *The learner Appreciates structures and functions of living organisms.*
- *This is assessed in the end of cycle biology practical paper as **item 2.***

The following areas of study are assessed as number 2 in the end of cycle paper;

Lower plants, Flowers, Fruits, Leaves, Arthropods, Bones and teeth.

Success criteria;

Ensure that you are well equipped with the following;

- *The ability to observe and identify specimens from the areas of study shown above.*
- *Adaptations of organisms for survival or their parts to perform their functions.*
- *Perfect drawing skills.*

Below are some example examination items and responses.

Item 8

Pastoralists around Nakaseke district have often complained about unknown organisms on their animals. Many of their animals keep rubbing their bodies on tree trunks in order to get rid of the organisms. When the pastoralists reported to the district veterinary officer, he collected the specimen from the affected cattle corridor and took them for further analysis in the laboratory. Specimen P(tick) Q (worker termite) R(housefly) and S (beetle) are some of the organisms collected.

Task
a) With reasons, classify the specimen into two common taxa.

Taxon	**Reasons**
Kingdom Animalia	Have limbs for locomotion Have mouth parts for heterotrophic nutrition
Phylum Arthropoda	Have jointed limbs Have segmented bodies Have exoskeleton

b) Explain how specimen P is adapted to causing its effect on the animals.

- Specimen P has a large abdomen to store blood
- Has a sharp pointed mouth part/ chelicera to pierce the skin of the animal for entry.
- Has a dull colour to camouflage on the body of the animals avoiding predation
- Has a flattened body to fit onto the cow's skin.

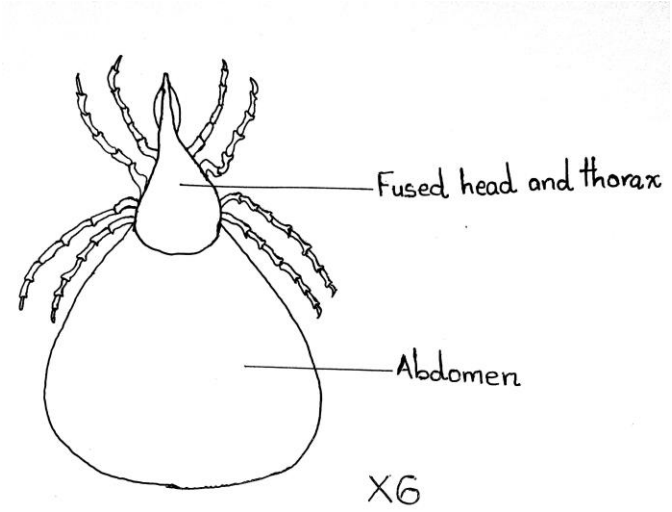
c) Identify the specimens using a dichotomous key

Dichotomous key

1 (a) Specimens with wings ..... go to 2
(b) Specimens without wings ..... go to 3
2 (a) Specimen with proboscis ..... R
(b) Specimen with mandibles ..... S
3 (a) Specimen with 6 legs ..... Q
(b) Specimen with 8 legs ..... P

d) Draw the specimen that is responsible for the effect on the animals. Label the main body parts.

Drawing of specimen P showing main body parts.



Item 9

Mr. Opio and Mr. Okello are neighboring farmers in Kigombya village in Mukono. When flowering time reached, their flowers matured. Mr. Opio observed that more bees visited Mr. Okello's garden than his. Mr. Okello continuously complained of decreased yield in his garden.
You have been provided with specimen K (maize inflorescence) from Mr. Opio's garden and L (hibiscus flower) from Mr. Okello's garden.

Task

Using observable features
a) Identify the specimen provided.

- L is insect pollinated flower

Observable features

Has brightly colored petals
It is scented
Has nectar guides

Has sticky pollen grains

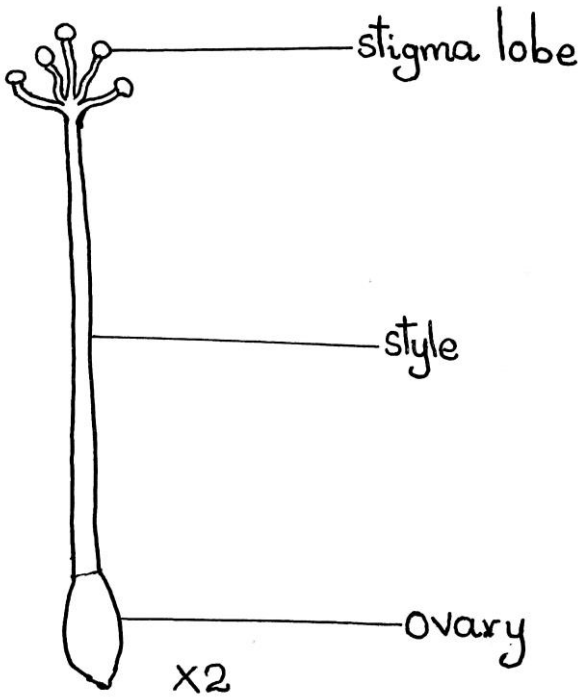
- K is a wind pollinated flower

Observable features
No scent
Produces many dusty pollen grains
Has long hanging anthers on the outside
b) Explain why more bees preferred Mr. Okello's garden.

- *Specimen L has brightly colored petals to attract pollinators that carry out pollination.*
- *L has scent that attracted pollinators.*
- *L has nectar guides on the specimen to lead the pollinators on to the nectar glands.*
- *L produces sticky pollen grains that attach on the body of the pollinator hence carrying it from the anthers to the stigma.*

c) Draw and label the female part of specimen L.

Drawing of the pistil of specimen L



Item 10

A health center in your community has recorded an increase in complaints from school children and boda -boda (motorcycle) riders about neck pain and difficulty in turning their heads.
A team of student researchers from your school is invited to investigate the possible biological causes. At the school lab, two bones from the vertebral column are provided: Specimen R and Specimen T. You are told one of these bones may help explain the problem. You are part of this team.
Task
(a) Examine the specimens given and outline the characteristic features of each.

Characteristics of specimen R

- It has a long neural spine.
- It has short transverse processes.
- It has tubercular demifacet on transverse process.
- It has a pair of articular facets.
- It has a large centrum.
- It has a large neural canal.
- It has a large neural arch.

Characteristics of specimen T

- It has a small neural spine.
- Transverse processes are divided into two parts called cervical ribs.

- It has vertebrarterial canals.
- It has a large neural canal.
- It has a small centrum.

(b) Describe how each specimen is adapted to its function.

Adaptations of Specimen R

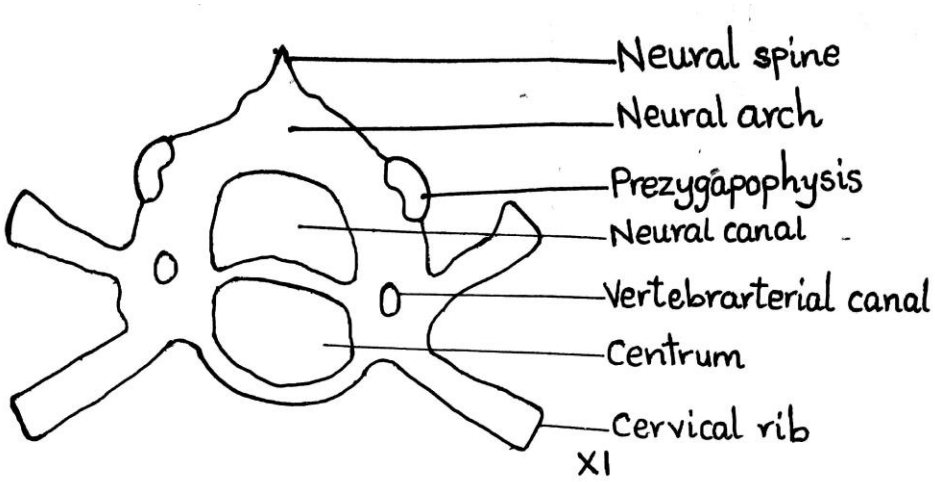
- Has demifacets on the centrum for articulation with heads of ribs.
- Has facets on the transverse processes for articulation with rib tubercles.
- Has a large centrum to support increased body weight and articulate with other vertebrae.
- Has a long neural spine providing a large surface area for attachment of thoracic muscles.
- Has strong prezygapophysis and postzygapophysis to stabilize the thoracic spine and limit excessive movement.
- Has strong transverse processes for attachment of thoracic muscles.

Adaptations of Specimen T

- Has a large neural canal to accommodate the enlarged cervical spinal cord.
- Has vertebrarterial canals for passage of vertebral arteries supplying the brain.
- Has divided transverse processes to increase surface area for muscle attachment.
- Has a small, lightweight centrum to allow flexible neck movement and to articulate easily with other vertebrae.
- Has a short neural spine to support and allow attachment of neck muscles.

(c) Draw and label the injured specimen in the complainants.

Drawing of the anterior view of specimen T



(NOTE: R-Thoracic, T-Cervical vertebra)

Item 11

Mr. Isa is an accountant who spends long hours sitting at his computer every day. To try to reduce chest tightness from sitting, he began going to a fitness center on his way home, where he lifts heavy weights. However, instead of improving, his condition worsened — he now experiences severe chest and lower back pain and can no longer continue with his work. After thorough examination, doctors advised him to rest for at least one month. However, the company management believes his condition is minor and is considering replacing him with another accountant.

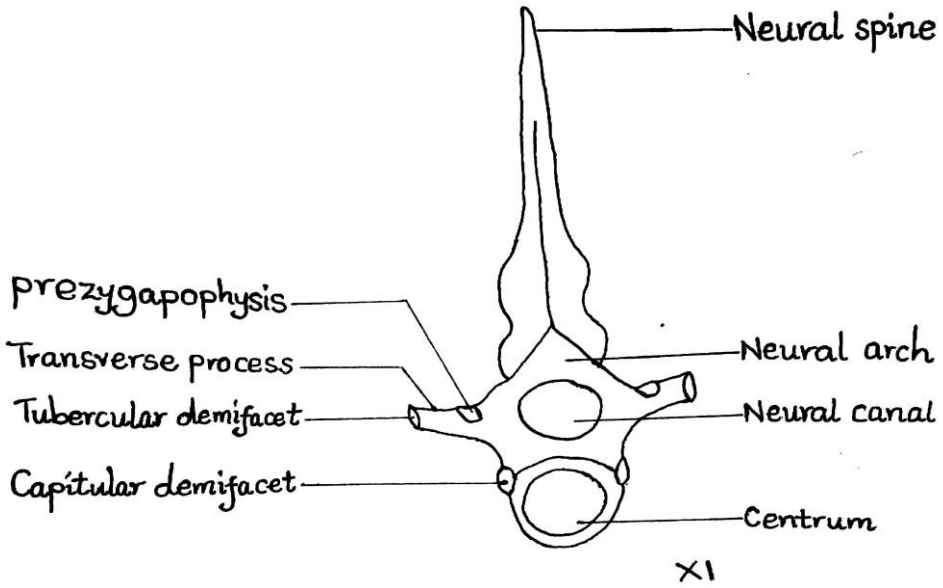
Task

(a) Identify specimens A and B

- *Specimen A: Thoracic vertebra*
- *Specimen B: Lumbar vertebra*

(b) **Draw and label specimen A and B, explain how the structure of each is related to function hence show the company management that Isa's problem is not minor.**

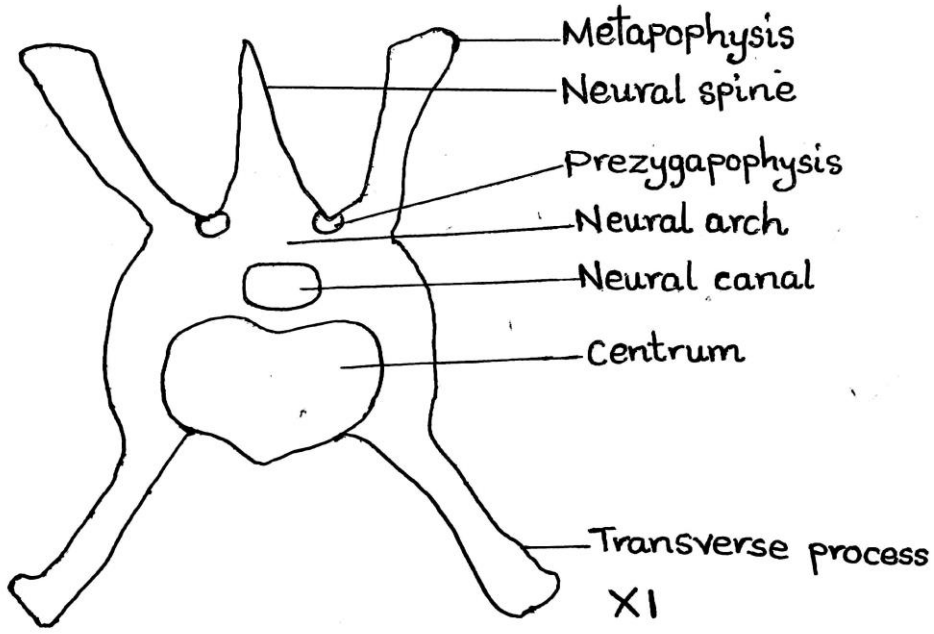
Drawing of the anterior view of specimen A



How specimen A is adapted to perform its function;

- Has demifacets on the centrum for articulation with heads of ribs.
- Has facets on the transverse processes for articulation with rib tubercles.
- Has a large centrum to support increased body weight and articulate with other vertebrae.
- Has a long neural spine providing a large surface area for attachment of thoracic muscles.
- Has strong prezygapophysis and postzygapophysis to stabilize the thoracic spine and limit excessive movement.
- Has strong transverse processes for attachment of thoracic muscles.

Drawing of the anterior view of specimen B



How specimen B is adapted to perform its function;

- Has a large centrum to bear great body weight and articulate with other vertebrae.
- Has a broad neural spine for attachment of strong abdominal and back muscles.
- Has a small neural canal to accommodate the lumbar spinal cord.
- Has large transverse processes that serve as levers for trunk and lower back muscles.
- Has large prezygapophysis and postzygapophysis positioned to allow flexion and extension but prevent twisting (rotation), thus providing stability.
- Has a metapophysis that provides extra surface for muscle attachment.

Conclusion

Mr. Isa's pain involves both the thoracic and lumbar vertebrae, which are vital for protecting internal organs, supporting body weight, and allowing controlled trunk and upper body movements. His condition is not minor; it is serious and requires adequate rest and proper treatment to prevent permanent damage to the spine and chest structures.

(c) What advice do you give to Mr. Isa on how to manage his condition?

- Avoid sitting for long hours; take breaks to stretch.
- Use an ergonomic chair with lumbar support.
- Avoid heavy lifting; follow guided, safe exercises.
- Strengthen back and core muscles gradually.
- Eat meals rich in calcium and vitamin D to strengthen bones and support recovery.
- Follow doctor's and physiotherapist's advice before resuming work.

Item 12

Jane and Shakirah are farmers whose gardens are located 100 meters apart. Immediately after weeding her overgrown bushy banana plantation, Jane went to help Shakirah plant maize in her garden. At harvest time, Shakirah observed other mature plants in her garden, some of which she had seen in Jane's banana plantation. Shakirah wondered how the other plants reached her garden.

Specimens X (desmodium fruit), Y and W are plant parts collected from the nature plants in Shakirah's garden.

Task

(a) (i) Using observable features, identify specimens X, Y and W.

- They are fruits.

Reasons;

- They have two scars.
- They have pericarp.

(ii) State the specimen(s) most likely to have been brought to Shakirah's garden unintentionally.

Give reasons for your response.

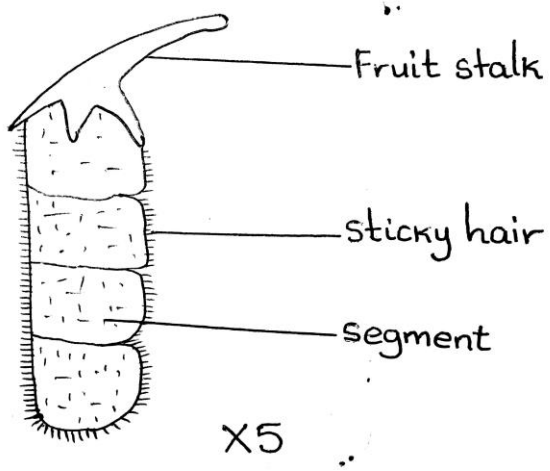
- Specimen X.

Reasons

- It has hairs for sticking on to the body hence being moved to Shakirah's garden.
- It has many segments which increase their multiplication speed.
- It is light so that it can easily be carried from one place to another.

(b) Draw and label specimen X.

A drawing of specimen X



PRACTICE ITEMS

Item 13

John wants to grow some plants to cover his bare, unfenced compound. However his compound is next to a grazing farm and the area receives little rainfall throughout the year. He wishes to grow two plants from options **W**, **X** and **Y** but he is undecided about which ones to choose.

Task

(a) Using observable features, identify the specimens.

(b) Help John make the right choice by providing reasons.

(c) Draw and label one leaf of specimen W.

(Note: W-Euphorbia, X-Lantana, Y-Hibiscus)

Item 14

Your grandmother is feeling stomach ache, she wants to make herbal medicine for the cure. She has a few samples of plant parts needed for the mix, but are not enough. She has shown you these plant parts and has sent you to go to the nearby forest and collect more. However, you are too busy and you want to send your little sister instead.

Task:

You are provided with specimen **K** and **L** which are samples of the plant parts needed.

a) Explain to your sister so that she can collect the right plant parts.

b) Which one of the two plant parts is likely to contain a bigger quantity of the medicine stored in it? Explain your answer.

c) Draw and label specimen K

(Note K-Ginger rhizome, L-Black Jack leaf)

Item 15

Rahumah has a book shelf at home, she is disturbed by one animal that keeps destroying her books. She doesn't want to use any chemical to destroy them, so she decided to be killing one by one using an object. Rahumah is finding it difficult to get rid of them as they keep hiding between the books. You have been provided with specimen **H** which is the the animal in Rahumah's book shelf.

Task

(a) Using observable features, identify specimen H.

(b) Explain how specimen H is able to destroy the books and hide in between the closely packed books.

(c) Draw and label one of the legs on the last segment of the thorax next to the abdomen.

(Note: H-Cockroach)

Item 16

Many farmers in Kizenga village usually find some of their crops destroyed by some organisms. Specimens **J**, **K**, **L** and **M** are some of the organisms that were collected from within and outside the garden.

Task

(a) Identify with reasons the organism most likely to destroy the farmers' crops.

(b) How can the collected organisms be identified using a dichotomous key?

(c) Draw and label the hind leg of specimen L

(Note: J-Spider, K-Soldier termite, L-Worker bee, M-Housefly)

Conclusive statement;

This item bank has been carefully developed to guide teachers and learners in assessing, deepening, and applying key concepts and competencies as required by the curriculum. It aims to promote critical thinking, accurate scientific understanding, and confidence among candidates preparing for UCE examinations. Users are encouraged to adapt and integrate these items to support active learning and continuous assessment for improved academic performance and lifelong scientific skills.

JBA JACOB

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